TELE-TECH

Caldwell-Clements Publication

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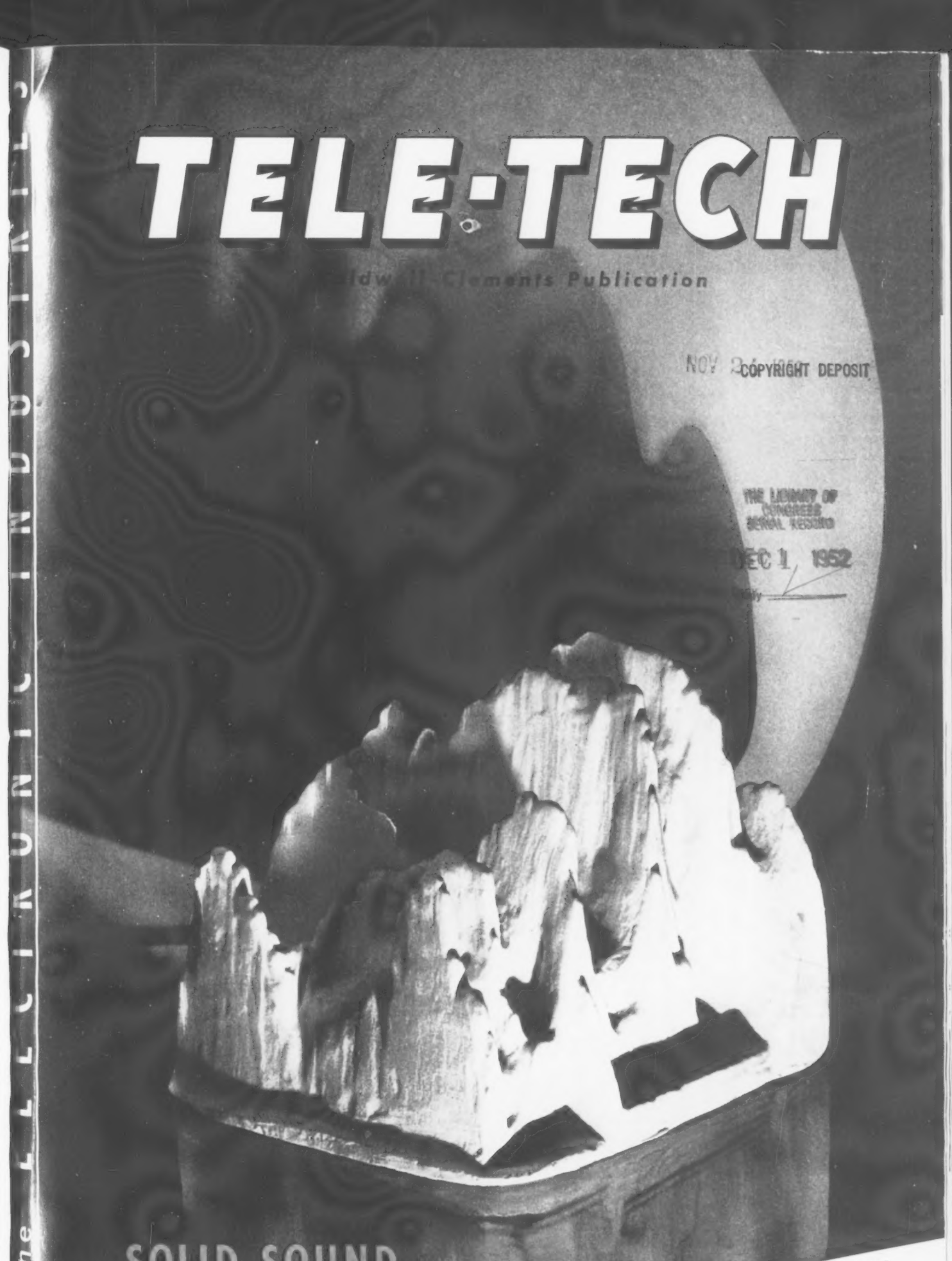

SOLID SOUND

November • 1952

for the ELECTRONIC INDUSTRIES

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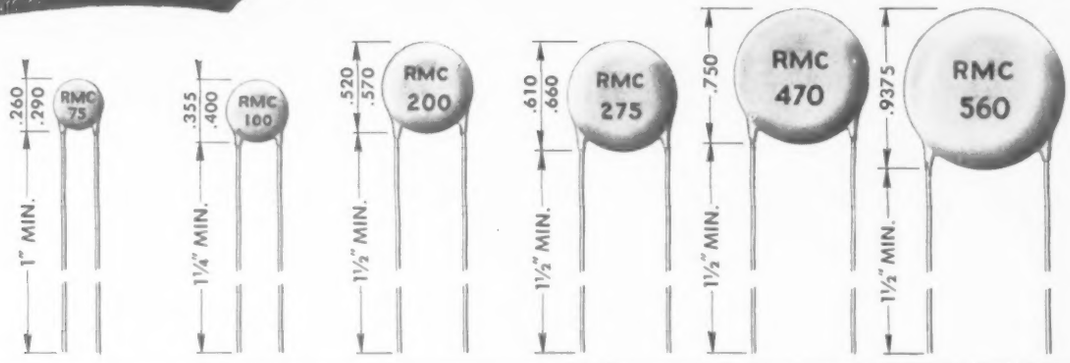
Temperature Compensating as well as By-Pass

DISCAPS®

are Rated at 1000 Working Volts!



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NPO	2- 12 MMF	13- 27	28- 60	61- 75 MMF	76-110 MMF	111-150 MMF
N- 33	2- 15	16- 27	28- 60	61- 75	76-110	111-150
N- 80	2- 15	16- 27	28- 60	61- 75	76-110	111-150
N- 150	2- 15	16- 30	31- 60	61- 75	76-110	111-150
N- 220	2- 15	16- 30	31- 75	76-100	101-140	141-190
N- 330	2- 15	16- 30	31- 75	76-100	101-140	141-190
N- 470	2- 20	21- 40	41- 80	80-120	121-170	171-240
N- 750	5- 25	26- 50	51-150	151-200	201-290	291-350
N-1400	15- 50	51-100	101-200	200-250	251-470	480-560
N-2200	47- 75	76-100	101-200	201-275	276-470	471-560

If the samples you need are not here — send for them.

SPECIFICATIONS

POWER FACTOR: LESS THAN .1% AT 1 MEGACYCLE

WORKING VOLTAGE: 1000 VDC TEST VOLTAGE: 2000 VDC

DIELECTRIC CONSTANT: P-100 14K N-750 88K N-2200 265K NPO 35K N1400 165K

CODING: CAPACITY, TOLERANCE AND TC STAMPED ON DISC

INSULATION: DUREZ PHENOLIC—VACUUM WAXED

LEAKAGE RESISTANCE: INITIAL 7500 MEG OHMS AFTER HUMIDITY 1000 MEG OHMS

LEADS: #22 TINNED COPPER (.026 DIA.)

LEAD LENGTH: ¼" BODY 1", 5/16" BODY 1¼", ½" AND LARGER BODY 1½"

TOLERANCES: ±5%, ±10%, ±20%

RMC DISCAPS are Designed to Replace Tubular Ceramic and Mica Condensers at LOWER COST

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers

TELE-TECH

& ELECTRONIC INDUSTRIES—RADIO-TELEVISION

NOV 24 1952

NOVEMBER, 1952

FRONT COVER: **"SOLID SOUND"**—*Model of the word "nine" is outgrowth of sound studies being carried on by Bell Telephone Labs. Initial step in the construction process is the spectrographic recording of the frequency-intensity response of a spoken word for a continuous series of time "slices." The slice patterns are inscribed on plastic sheets and stacked to form a "loaf" of the entire word. A mold is then made and the plaster model cast. The resulting three-dimensional piece presents a full visual picture of the word, showing characteristics not readily evident in ordinary spectrograms. In the model, frequency is plotted along the horizontal, oblique right axis; time along the horizontal, oblique left axis; and intensity vertically. Studies indicate that the major ranges for any one particular word are distinctive and similar for a variety of speakers, but vary in the smaller ridges or foothills depending on the speaker's emphasis and inflection. Present object of the research is the solution of existing speech transmission problems. Long range aim is the development of voice-operated telephone dialing and teletype systems.*

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Edited for the 19,000 top influential engineers in the Tele-communications and Electronic Industries, TELE-TECH each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, TELE-TECH is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and developments are sought by the leaders in the many engineering fields listed below.

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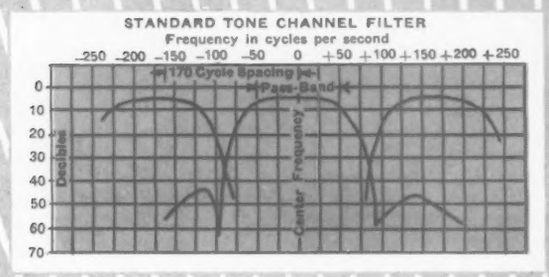
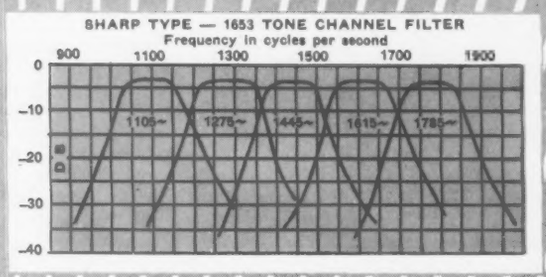
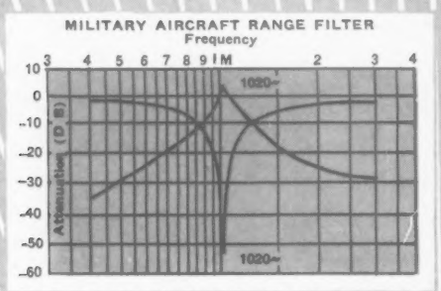
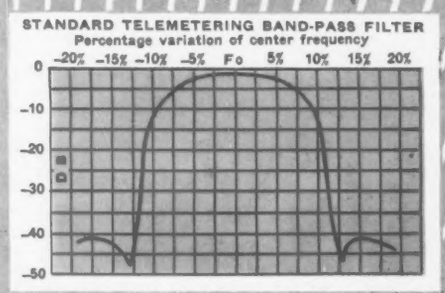
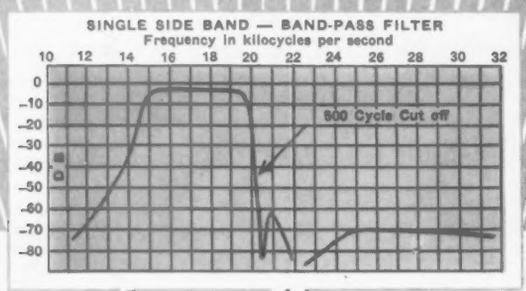
EXPERTS *in Filters for the Military*

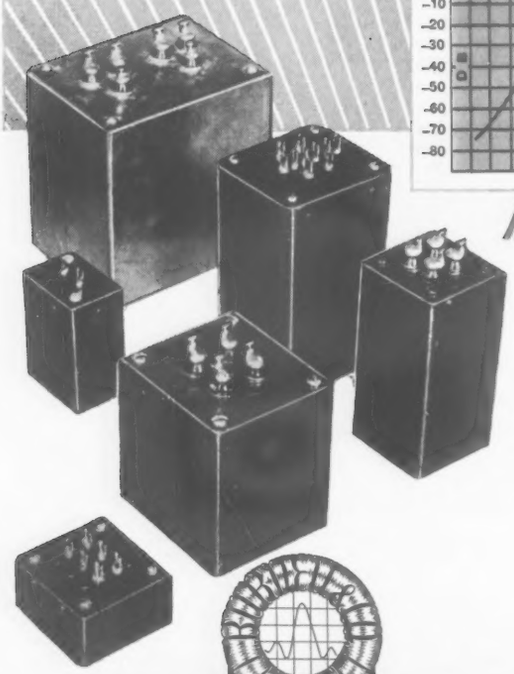



SHARP TYPE — 1653 TONE CHANNEL FILTER
Frequency in cycles per second
900 1100 1300 1500 1700 1900
1105~ 1275~ 1445~ 1615~ 1785~
DB









Burnell High Quality Toroids and Audio Filters

With each new technological advancement in military electronics the design engineer has had to cope with more difficult network problems.

Today it is not sufficient for the engineer just to know what signal to clean up or which to reject or separate.

His filter requirements have become increasingly complicated by other critical factors such as phase shift, linearity, transient response, extreme accuracy through wide temperature ranges etc.

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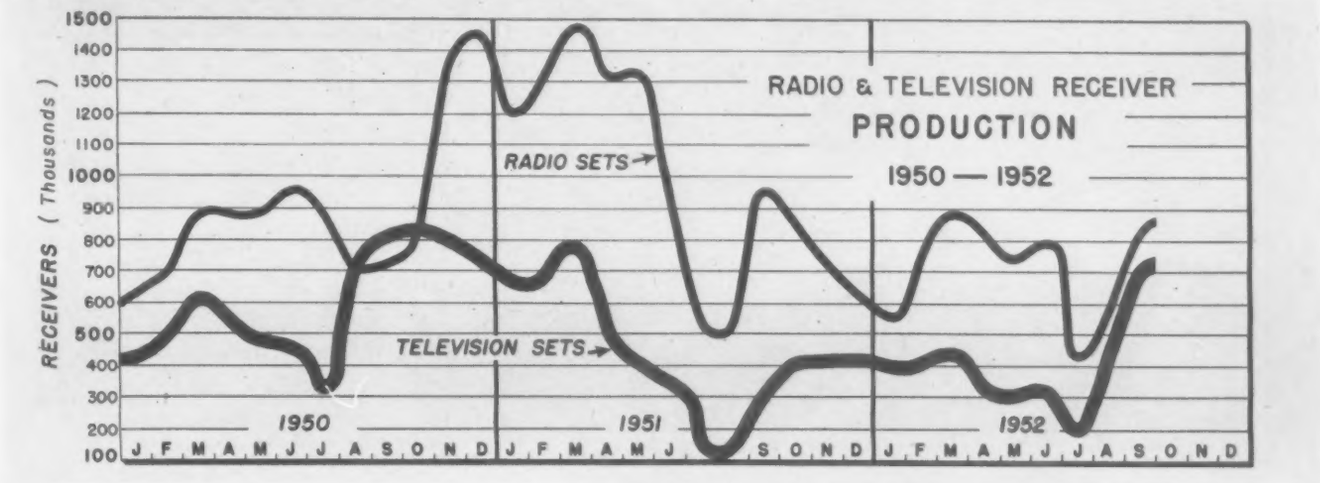
EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

TELE-TOTALS

Facts & Figures Round-up of the Electronic Industries, November, 1952



Radio and TV Receiver Production

	TV		Radio
Sept. 1952		Home	309,459
		Battery	138,622
		Auto	228,290
		Clock	178,456
Total	719,310		854,827
First nine months through Sept. 1952		Home	2,561,018
		Battery	1,005,668
		Auto	2,020,350
		Clock	1,128,817
Total	3,666,407		6,715,853
Year 1951	5,562,000		12,895,000
Year 1950	7,520,000		14,630,000

Broadcast Stations in U. S.

	AM	FM	TV
Stations on Air	2360	628	110 VHF & 1 UHF
Under Construction (CPs)	132	68	38 UHF & 11 VHF
Applications Pending	265	11	296 UHF & 445 VHF

TELEVISION-SET OWNERS, NOV. 1, 1952

Market Area	No. TV Stations	TV Sets in Use
Atlanta	3	210,000
Baltimore	3	430,000
Binghamton	1	93,500
Birmingham	2	128,000
Boston	2	980,000
Buffalo	1	298,000
Charlotte	1	167,000
Chicago	4	1,300,000
Cincinnati	3	354,000
Cleveland	3	680,000
Columbus	3	235,000
Dallas-Fort Worth	1	195,000
Davenport-Rock Island	2	146,000
Dayton	2	209,000
Denver	1	45,000
Des Moines (Ames)	1	95,500
Detroit	3	785,000
Erie	1	94,500
Grand Rapids-Kalamazoo	1	186,000
Greensboro	1	101,000
Houston	1	186,000
Huntington	1	96,000
Indianapolis-Bloomington	1	312,000
Jacksonville	1	71,500
Johnstown	1	178,000
Kansas City	1	234,000
Lancaster	1	172,000
Lansing	1	106,500
Los Angeles	7	1,300,000
Louisville	2	156,000
Memphis	1	152,000
Miami	1	111,000
Milwaukee	1	370,000
Minneapolis-St. Paul	2	340,000
Nashville	1	82,000
New Haven	1	338,000
New Orleans	1	120,000
New York	7	3,260,000
Norfolk	1	129,000
Oklahoma City	1	97,600
Omaha	2	146,000
Philadelphia	3	1,180,000
Phoenix	1	42,000
Pittsburgh	1	515,000
Portland Ore.	1	15,000
Providence	1	238,000
Richmond	1	147,000
Rochester	1	166,000
Salt Lake City	2	81,000
San Antonio	2	96,000
San Diego	1	127,000
San Francisco	3	470,000
Schenectady	1	234,000
Seattle	1	180,000
St. Louis	1	442,000
Syracuse	2	180,000
Toledo	1	213,000
Tulsa	1	81,000
Utica	1	78,000
Washington	4	410,000
Wilmington	1	124,000
Not Interconnected		
Albuquerque	1	19,000
Brownsville	1	11,600
Total for All Stations		19,739,700

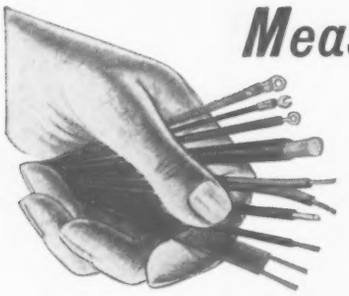
TIMETABLE of NEW TV STATIONS COMING on the AIR

A geographical listing of the 59 new commercial TV stations and 9 noncommercial educational outlets for which post-freeze FCC grants and construction permits had been issued through October 4, 1952. Information on expected start of telecasting is from station operator's estimate, as furnished TELE-TECH.

STATE AND CITY	CALL LETTERS	CHANNEL	DATE ON AIR
ALA.: Mobile	WKAB-TV	48	December, '52
Montgomery	WCOV-TV	20	March '53
ARK.: Little Rock	KWFT	17	*
CALIF.: Fresno	KMJ	24	*
Los Angeles (NCE)	*	28	*
COL.: Denver	*	20	*
Denver	KBTV	9	October 12, '52
Denver	KFEL-TV	2	July 21, '52
Denver	*	26	*
CONN.: Bridgeport	WICC-TV	43	January, '53
Bridgeport	*	49	*
New Britain	WKNB-TV	30	January, '53
FLA.: Ft. Lauderdale	WITV	17	*
Ft. Lauderdale	WFTL-TV	23	March, '53
ILL.: Peoria	WEEK-TV	43	March, '53
Rockford	*	39	Feb. or Mar., '53
IND.: South Bend	*	34	*
KANS.: Manhattan (NCE)	*	8	*
KY.: Ashland	*	59	*
LA.: Baton Rouge	WAFB-TV	28	Feb., '53
MASS.: Fall River	*	46	May, '53
New Bedford	*	28	*
Springfield-Holyoke	WWLP	61	January, '53
Springfield-Holyoke	WHYN-TV	55	March, '53
MICH.: Ann Arbor	WPAG	20	*
Flint	WCTV	28	January, '53
Saginaw	*	12	*
MISS.: Jackson	*	25	*
NEB.: Lincoln	*	57	*
N. J.: Asbury Park	*	58	*
N. Y.: Albany (NCE)	*	17	*
Binghamton (NCE)	*	46	*
Buffalo (NCE)	*	23	*
New York City (NCE)	*	25	*
Rochester (NCE)	*	21	*
Syracuse (NCE)	*	43	*
OHIO: Akron	WAKR-TV	49	Winter, '53
Massilon	WMAC	23	March, '53
Youngstown	*	21	*
Youngstown	WFMJ-TV	73	*
Youngstown	WKBN-TV	27	*
ORE.: Portland	KPTV	27	Sept. 18, '52
PA.: Harrisburg	WHP-TV	33	*
New Castle	WKST-TV	45	January, '53
Reading	WEEU-TV	33	July 1, '53
Reading	WHUM-TV	61	December, '52
Scranton	*	73	*
Scranton	WGBI	22	April 1, '53
York	WNOW-TV	49	Feb. or Mar., '53
York	WSBA-TV	43	Nov., '52
Wilkes-Barre	*	28	*
Wilkes-Barre	*	34	*
S. C.: Columbia	WNOK-TV	67	Jan., '53
Columbia	WCOS-TV	25	Spring, '53
TENN.: Chattanooga	*	43	*
Chattanooga	*	49	*
TEX.: Austin	*	18	*
Austin	KTBC-TV	7	December 1, '52
Austin	*	24	*
El Paso	KROD-TV	4	December, '52
El Paso	KTSM-TV	9	January, '53
Houston (NCE)	*	8	*
VA.: Roanoke	WROV-TV	27	December, '52
Roanoke	WSLS-TV	10	January 1, '53
WASH.: Spokane	KHQ-TV	6	Spring, '53
Spokane	KXLY-TV	4	December, '52
HAWAII: Honolulu	KGMB-TV	9	April-June, '53
PUERTO RICO: San Juan	WKAQ-TV	2	April, '54

* Information not available at press time.
(NCE) Noncommercial educational.

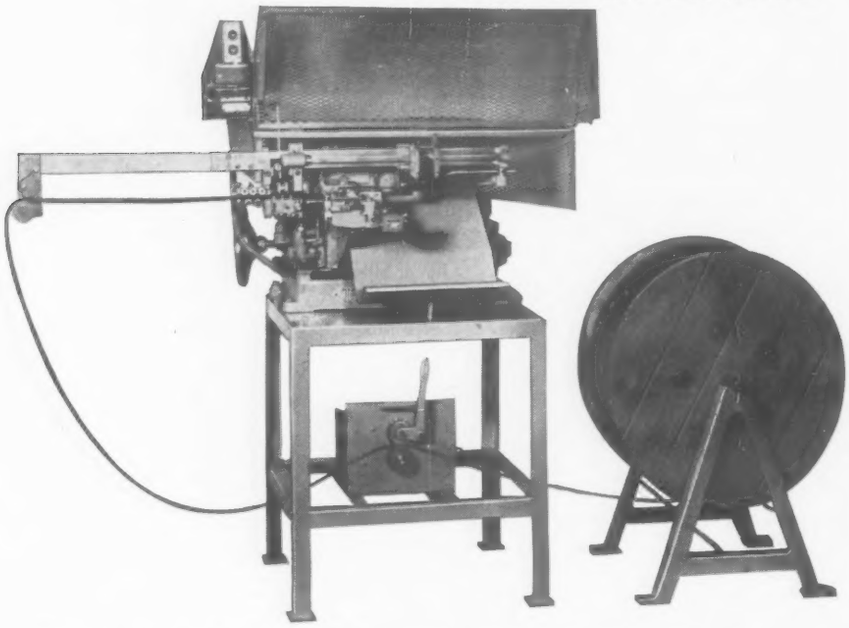
See also Caldwell-Clements Statistics in World Almanac, Encyclopaedia Britannica, National Industrial Conference Board Fact Book, and "Information Please" Almanac



Measure, Cut and Strip Insulated Wire*

IN ONE SPEEDY OPERATION

on ARTOS Automatic MACHINES



Does your production require cutting and stripping of insulated electric wire, cord, cable, etc.?

You can produce finished leads *much faster* . . . as many as 3000 per hour in 15-in. lengths . . . on this Artos Automatic Machine. Substantial savings are obtained over the best manual or semi-automatic methods.

Operation is fully automatic—wire is taken from the reel, measured, cut to length and stripped at one or both ends. Unskilled help can handle the machine. Set-up is easy for different wire types, cut lengths and stripped lengths.

MODEL CS-6E CAPACITY

Finished Pieces Per Hour—From 3000 per hour up to 15 in. lengths to 500 per hour in 64-97 in. lengths.

Maximum Stripping Length—1½ in. at each end (greater stripped lengths are special).

Maximum Cutting Length—97 in.

Minimum Cutting Length—2 in. (also as short as ⅞ in. under certain conditions).

Types of Wire Handled—Practically all types of solid or stranded single conductor wires, parallel cord, heater cord, service cord, etc.

Maximum Wire Size—No. 10 stranded or No. 12 solid.

Other Artos Machines

The complete line of Artos automatic wire cutting and stripping machines will handle *cut lengths* from 1 in. to 60 ft., *stripped lengths* to 6½ in. at one end and 8½ in. at the other, *wire* from No. 12 to No. 000 gauge, and up to 3600 pieces per hour. Ask for recommendations on your problems.

WRITE FOR BULLETIN

Get the complete story. Write for Bulletin 35-C on Artos Model CS-6 machines.

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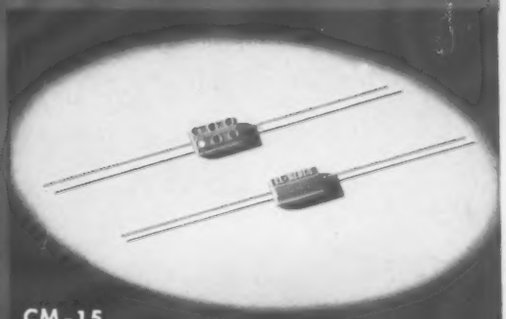

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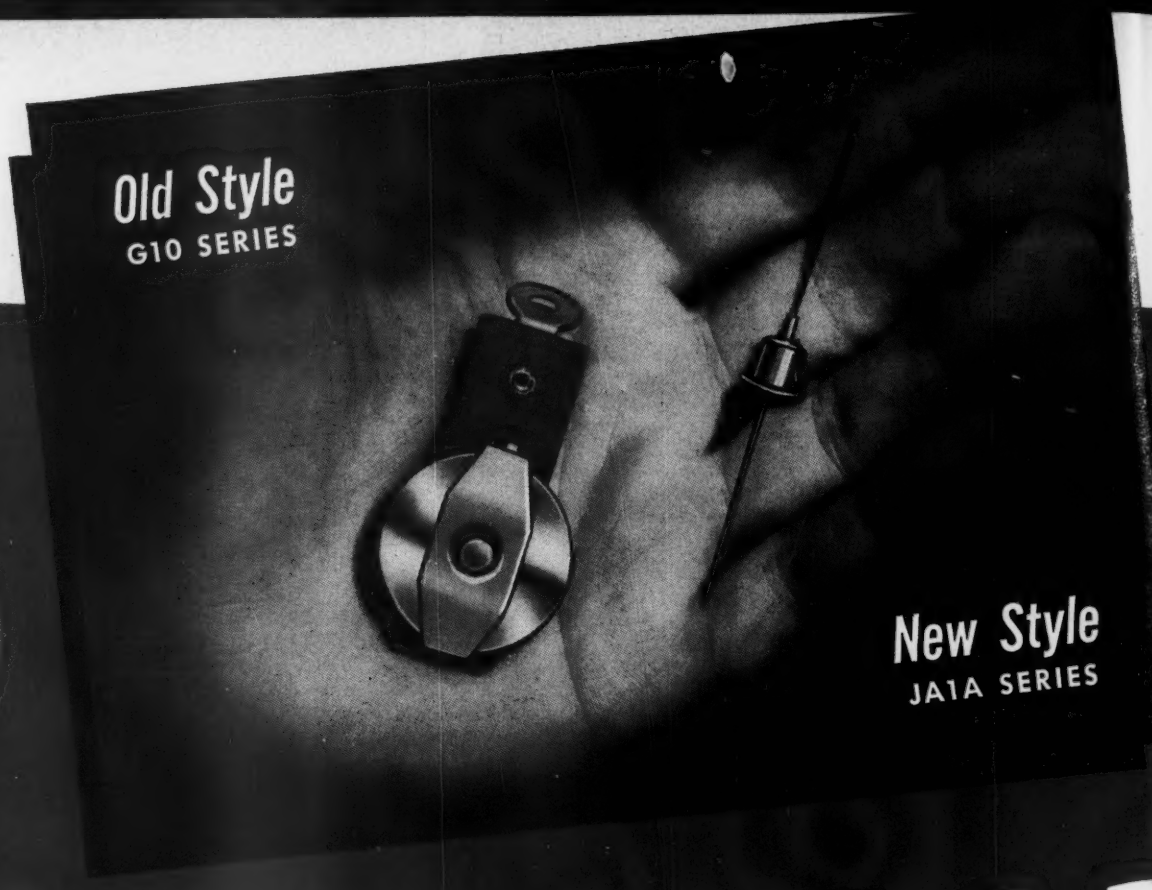

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- **Re-designed** to meet all military humidity tests and shock and vibration requirements.
- **High Output Voltage** and improved back current characteristics.

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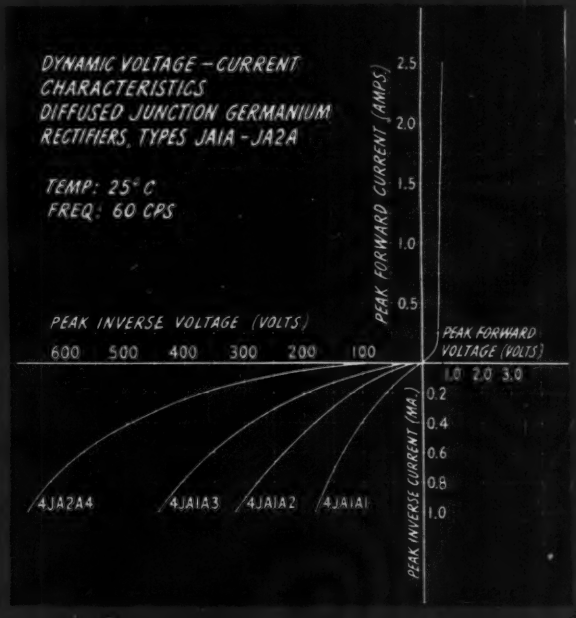
	4JA1A1	4JA1A2	4JA1A3	4JA2A4
PEAK INVERSE VOLTAGE (volts) *	100	200	300	400
PEAK FORWARD CURRENT (amps) *	0.5	0.5	0.5	1.3
D.C. OUTPUT CURRENT (Ma) *	150	150	150	400
D.C. SURGE CURRENT (amps)	25	25	25	25
FULL LOAD VOLTAGE DROP (volts)	0.6	0.6	0.6	0.7
OPERATING FREQ. (kc)	50	50	50	50

*Typical absolute maximum ratings. For other combinations refer to Fig. 1.

DIFFUSED JUNCTION RECTIFIER



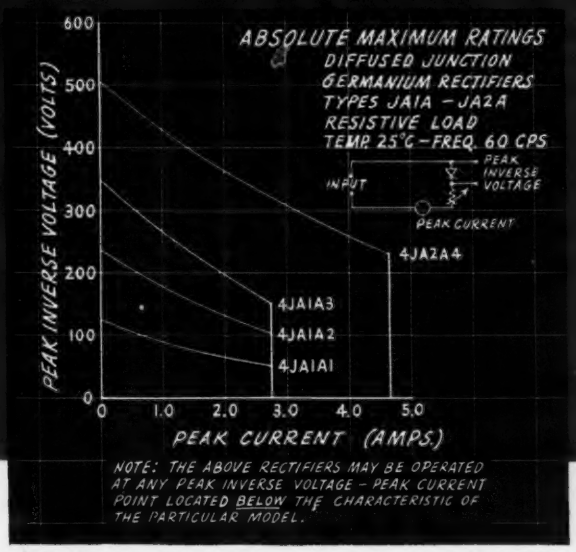
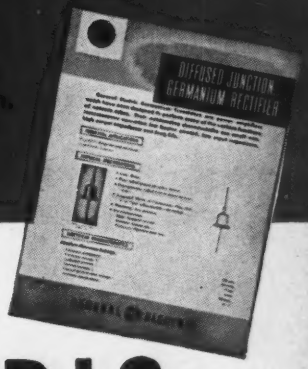

ABSOLUTE MAXIMUM RATINGS
DIFFUSED JUNCTION
GERMANIUM RECTIFIERS
TYPES JA1A – JA2A
RESISTIVE LOAD
TEMP. 25°C – FREQ. 60 CPS
INPUT
PEAK INVERSE VOLTAGE
PEAK CURRENT
4JA2A4
4JA1A3
4JA1A2
4JA1A1
PEAK INVERSE VOLTAGE (VOLTS)
600 500 400 300 200 100 0
0 1.0 2.0 3.0 4.0 5.0
PEAK CURRENT (AMPS.)
NOTE: THE ABOVE RECTIFIERS MAY BE OPERATED AT ANY PEAK INVERSE VOLTAGE – PEAK CURRENT POINT LOCATED BELOW THE CHARACTERISTIC OF THE PARTICULAR MODEL.

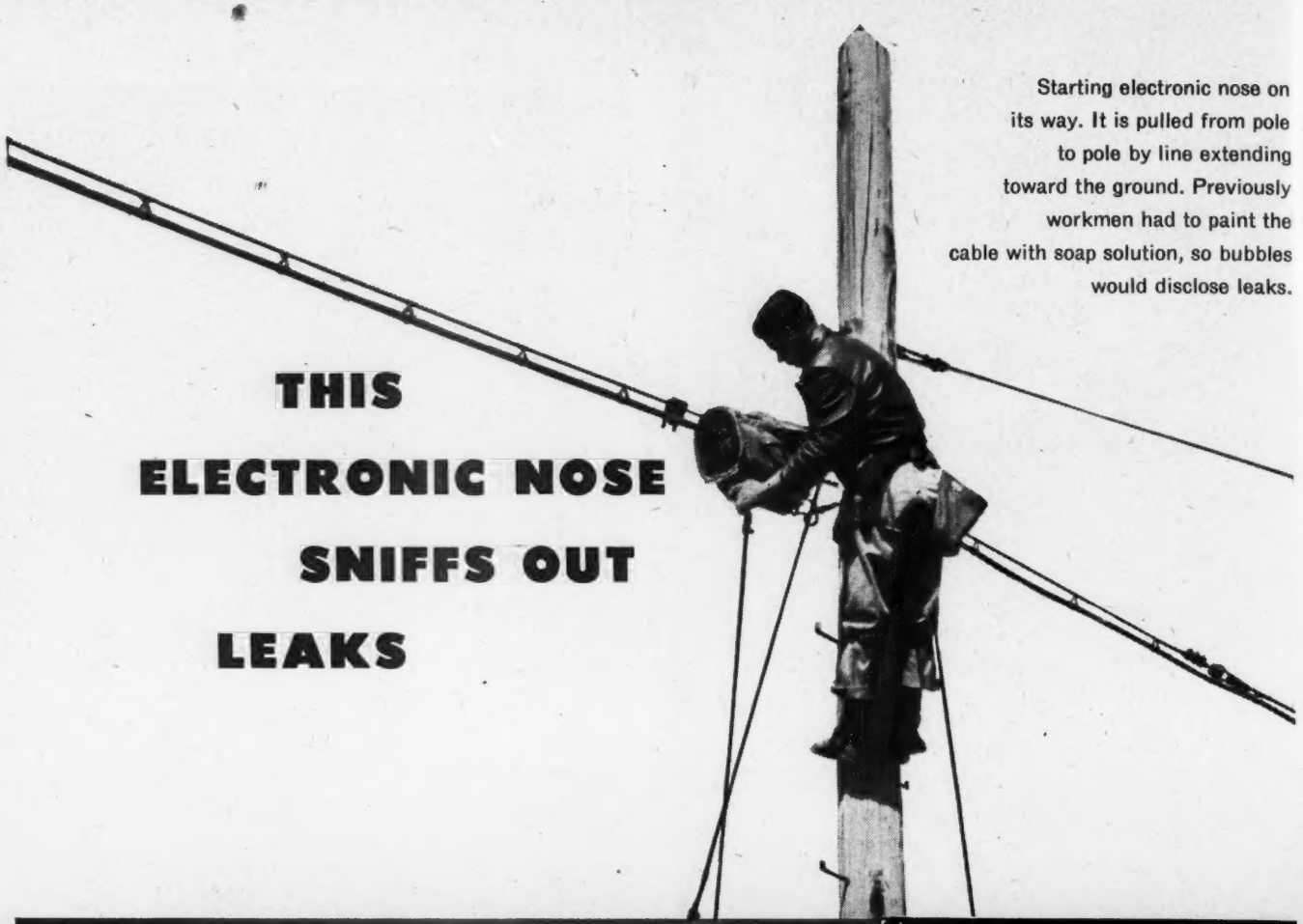
FIG. 1

NEW BULLETIN—Complete specifications on the diffused junction rectifier are contained in this illustrated bulletin. It's yours on request. Write: General Electric Company, Section 48112, Electronics Park, Syracuse, N. Y.

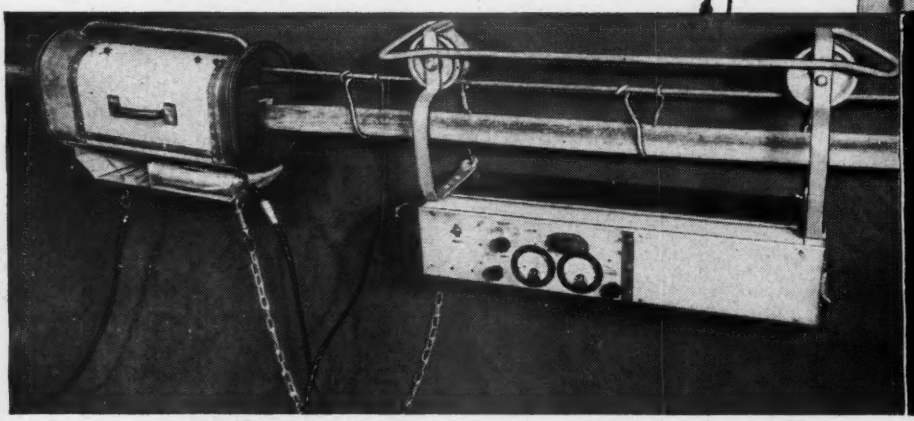


GENERAL ELECTRIC

THIS ELECTRONIC NOSE SNIFFS OUT LEAKS



Starting electronic nose on its way. It is pulled from pole to pole by line extending toward the ground. Previously workmen had to paint the cable with soap solution, so bubbles would disclose leaks.



For test, the cable is cleared of protective nitrogen or air, and filled with Freon gas. Case at left collects escaping gas which operates Freon-sensitive detector underneath. At points where Freon escapes through sheath cracks, the box at right—a combined control unit and power supply—rings a bell. Workmen mark the point of leak for later repair.

After years of buffeting by the wind, even tough telephone cable sometimes shows its age. Here and there the lead sheath may crack from fatigue or wear through at support points. Before moisture can enter to damage vital insulation, leaks must be located and sealed.

To speed detection, Bell Laboratories scientists constructed an electronic nose which *sniffs* out the leaks. Using an electrically operated element developed by the General Electric Company, the device detects leaks of as little as 1/100 cubic foot per day. Sheath inspection can be stepped up to 120 feet per minute.

Thus Bell scientists add findings in other fields to their own original research in ways to make your telephone system serve you better. On the other hand their discoveries are often used by other industries. Sharing of scientific information adds greatly to the over-all scientific and technological strength of America.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields

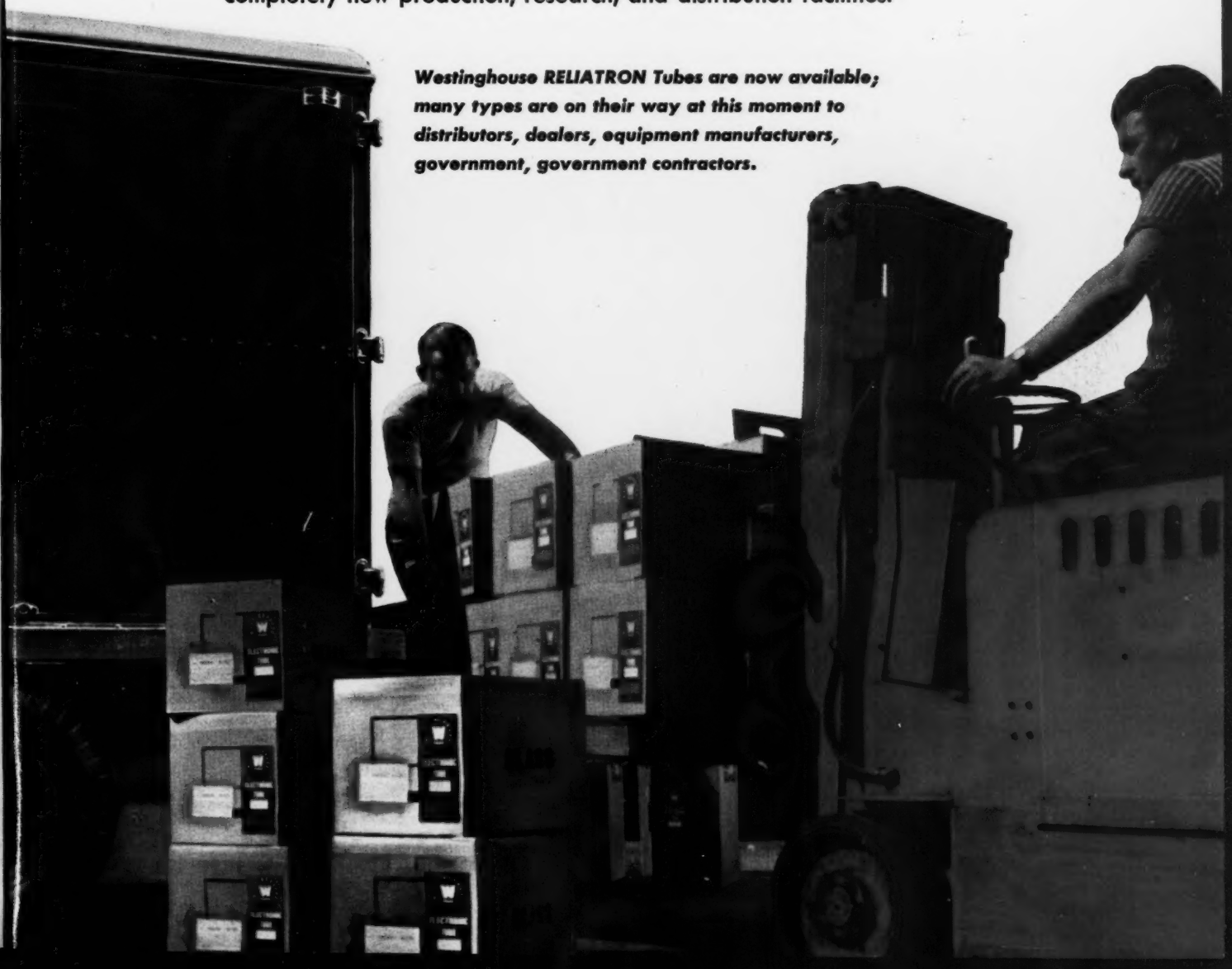
Westinghouse

announces a great new division to manufacture a full line of RELIATRON™ TUBES

Receiving Tubes—
Television Picture Tubes—
Power Tubes

Westinghouse proudly announces a completely new division—*THE ELECTRONIC TUBE DIVISION*. Its aim is this: To become the leader of the industry in providing better electronic tubes and better service to all tube users.

To provide this new standard of service to all branches of the electronic tube industry, Westinghouse has equipped its new tube division with completely new production, research, and distribution facilities.



Westinghouse RELIATRON Tubes are now available; many types are on their way at this moment to distributors, dealers, equipment manufacturers, government, government contractors.

THE

Westinghouse

ELECTRONIC TUBE DIVISION

- Experienced Personnel
- Modern Facilities
- Rigid Standards

Westinghouse offers the electronics industry thirty years of experience in tube development, application, and manufacture. From this experience have come many of the tube innovations that today are the basis for the electronics industry. In all cases, Westinghouse customers benefited by being first with new types. The list at the right indicates a few Westinghouse contributions.

The personnel of the new Westinghouse Electronic Tube Division comprise a brilliant engineering, production and sales team—recruited from Westinghouse's 46 manufacturing divisions and key experts from throughout the industry.

Tubes produced by Westinghouse will bear the name . . .

RELIATRON

. . . an unbreakable bond of reliability and electronics. It indicates performance and dependability on a new scale for the electronic tube industry.

Look at This Brilliant History of Westinghouse Electronic Tube Achievements:

★ The Westinghouse-designed WD-11 tube was the first dry battery type and was part of the first commercial radio receiver ever produced in America.

★ Westinghouse was the first manufacturer to develop and mass-produce tubes utilizing an indirectly heated cathode.

★ Westinghouse designed and produced the first ac-operated detector tube, the Type 27.

★ Westinghouse established the first commercial radio broadcast station, KDKA, in 1920 and thus opened the mass market for home radios.

★ Basic development and demonstration of the cathode ray television system was performed in Westinghouse laboratories and patented in 1929.

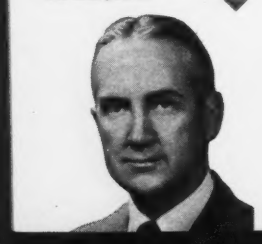
★ Westinghouse developed and introduced both electromagnetic and electrostatic types of cathode ray tubes in 1930.

★ Westinghouse design engineers invented the Ignitron, which solved long-standing problems of precise, high-speed switching of heavy electric currents.

★ Westinghouse pioneered in high-powered transmitting tubes for use in both pulsed and CW radar applications. The famous Westinghouse Type WL-530 was in the Pearl Harbor radar set which gave the warning of the approach of Japanese planes in 1941. This tube led the way to all subsequent radars.

THESE MEN LEAD THE WESTINGHOUSE ELECTRONIC TUBE DIVISION TEAM

HAROLD G. CHENEY,
General Sales Manager:
A Westinghouse tube and lamp sales executive for 31 years, Mr. Cheney was appointed General Sales Manager of the Electronic Tube Division in August, 1951. Prior to his appointment he was assistant to the general lamp sales manager and supervisor of lamp sales contracts. He was a key factor in giving to the lamp industry the stabilizing influence of Westinghouse's fair, sound business and sales policies.



EUGENE W. RITTER,
Vice-President and Manager:
For eight years he was with the Corning Glass Works as vice-president and director, later president of the Corning Glass Works of South America. Previously he had been employed by the Radio Corporation of America for 12 years as a member of the Radio Tube Design and Development Division, manager of the Radiotron Company, later vice-president of the RCA Manufacturing Company.

JAMES L. BROWN,
Manager, Receiving and Cathode Ray Tube Sales:
For 14 years Mr. Brown was an electronic tube and apparatus sales executive and engineer for the General Electric Company—on the West Coast for 7 years and later as central regional sales manager for receiving and television picture tubes. He is a former purchasing agent of Hoffman Radio Company.

DR. E. A. LEDERER,
Manager of Engineering:
He was formerly chief engineer for National Union Radio Corporation and for 17 years was a member of the tube development staff of Radio Corporation of America. He participated in early vacuum tube development work with the Westinghouse research and engineering staffs from 1923 to 1930.

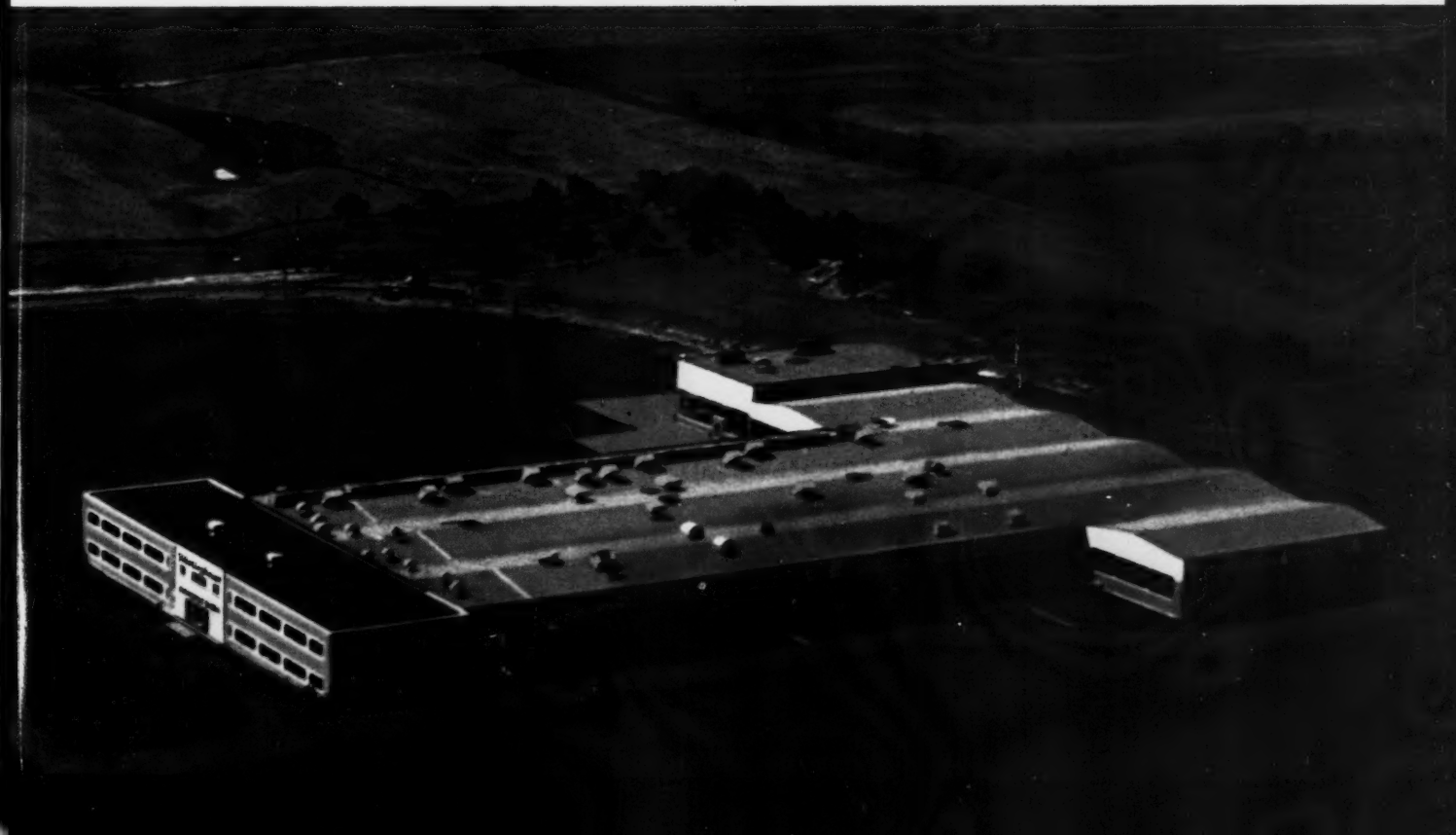
JOHN J. DOYLE,
Manager, Power Tube Sales:
A veteran of 25 years' Westinghouse service, Mr. Doyle was manager of electronic tube sales to distributors prior to his present appointment. Previously he was manager of electronic tube parts sales and has held various sales executive positions in the Lamp Division.

WESTINGHOUSE IN ELMIRA, NEW YORK

360,000 square feet of steel, glass and brick designed for one thing —to house the most efficient electronic tube production in the world. Here, completely modern straight-line exhaust, Lehr, and screen settling equipment produce Westinghouse RELIATRON Television Picture Tubes of unsurpassed quality. Here also are produced the famous Westinghouse line of power, transmitting, industrial and special purpose tubes. Plant layout is designed around efficient, straight production lines. Into them feed raw materials and sub-assemblies. From them, tubes enter an exacting testing cycle. To assure prompt delivery, tubes are loaded directly into trucks or railroad cars waiting on Westinghouse's own spacious rail siding. Here at Elmira, too, is located the headquarters of the Westinghouse Electronic Tube Division with sales, engineering and production management ready to extend a warm welcome to you.

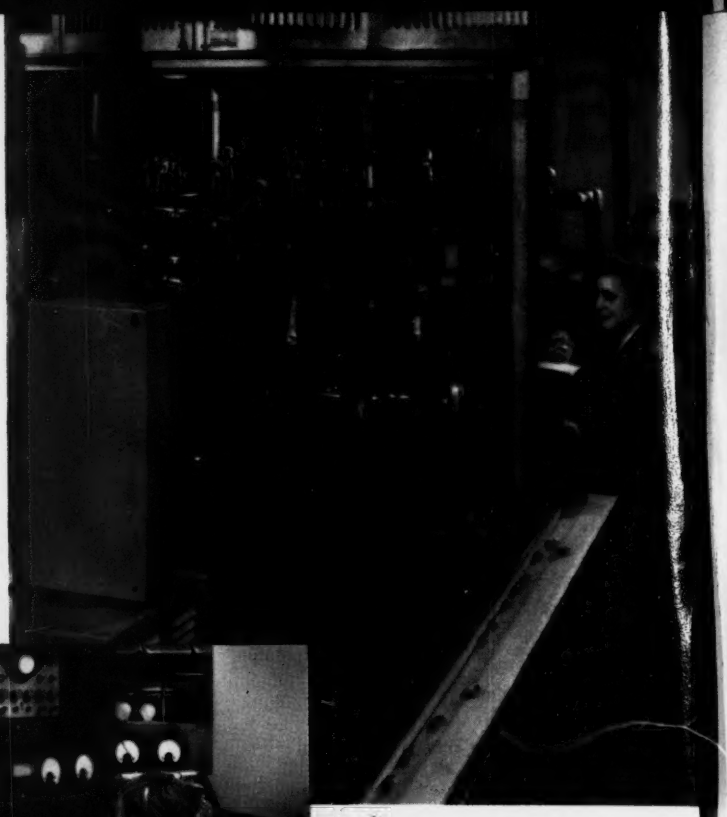
WESTINGHOUSE IN BATH, NEW YORK

Located at Bath in the scenic Finger Lakes region of upstate New York, this Westinghouse Receiving Tube Plant is another 220,000 square feet of modern production efficiency. It lies only a few miles from a major source of glass tube envelopes. It is served by sidings of one of the nation's leading railroads—only hours away from all principle markets. It is less than one hour from the Elmira factory and the advice and supervision of the Division's headquarters staff. Here at Bath, the most modern cathode-coating, grid-winding, spot welding and sealex equipment is operated by the industry's leading craftsmen. Famous Westinghouse quality control standards rule from raw material to testing of finished tubes. From this plant are shipped the finest receiving tubes in the industry—Westinghouse RELIATRON Tubes.



RELIATRON

TUBES are backed by Westinghouse reliability

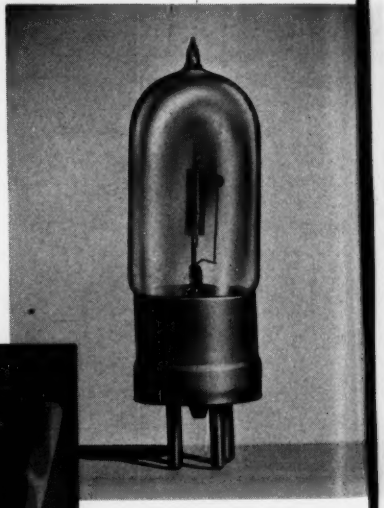


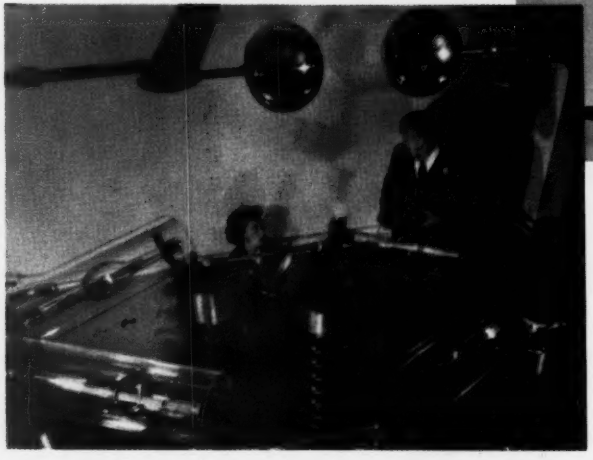
Sealex units at Bath, New York, turn out miniature tubes for government and commercial use. From here, tubes enter a rigorous program of checks and testing.

Here, an early Westinghouse WD-11 tube, one of the earliest types ever made, is shown just as it was used in the first commercial radio receivers.

This exclusively-Westinghouse quality control test set is one of a large battery of equipments which provide you with tubes of the highest quality and reliability.

Basic and application research are of prime importance in the Westinghouse Electronic Tube Division's plans. Such research has helped build the tube industry, and has made Westinghouse dominant in development.





TUBE RESEARCH AND DEVELOPMENT

The Westinghouse position of leadership in electrical and electronic manufacturing is founded on the untiring efforts of its research staff. The Electronic Tube Division is already at work improving present tube types and developing new types for superior service and new applications, including UHF.

QUALITY CONTROL

RELIATRON tube performance is assured by an exacting program of quality control. Every step in the manufacture of RELIATRON Tubes—from raw materials to finished product—must meet standards which are the toughest in the industry.

ENGINEERING AND SALES SERVICES

Whatever your problem, whether you are an equipment manufacturer, government laboratory, or parts distributor, you will find Westinghouse sales representatives and application engineers in your area at your service. Sales and engineering offices are located strategically throughout the country to serve you.

ADVERTISING

Trade acceptance of Westinghouse RELIATRON Tubes will be supported by a nationwide advertising campaign second to none. Technical data, pricing service and application information are available to all tube users. Sales promotion programs for distributors and service dealers will be hard-hitting, sure sales builders. Your product or service will profit from consumer acceptance built by the tremendous national advertising of the name "Westinghouse."

DISTRIBUTORS, EQUIPMENT MANUFACTURERS, WRITE NOW

For complete information on the Westinghouse line of RELIATRON Receiving Tubes, Television Picture Tubes, and Power Tubes, write or wire Westinghouse Electric Corporation, Dept. 101, Elmira, New York. Or call your nearest Westinghouse Electronic Tube Division Sales Office.

YOU CAN BE SURE... IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

to the **E. E.** *or* **PHYSICS GRADUATE**

with experience in

RADAR OR ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's large electronics organizations, is now creating a number of new openings in an important phase of its operation.

Here is what one of these positions offers you:

1. THE COMPANY

Hughes Research and Development Laboratories is located in Southern California. We are presently engaged in the development of advanced radar devices, electronic computers and guided missiles.

2. THE NEW OPENINGS

The positions are for men who will serve as technical advisors to the companies and government agencies purchasing Hughes equipment. Your specific job would be to help insure the successful operation of our equipment in the field.

3. THE TRAINING

Upon joining our organization, you will work in our Laboratories for several months until you are thoroughly familiar with the equipment you will later help the Services to understand and properly employ.

4. WHERE YOU WORK

After your period of training (at full pay), you may (1) remain with the company Laboratories in Southern California in an instruction or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and for moving household effects, and married men keep their families with them at all times.

5. YOUR FUTURE

You will gain all-around experience that will increase your value to the company as it further expands in the field of electronics. The next few years are certain to see a large-scale commercial employment of electronic systems—and your training in the most advanced electronic techniques now will qualify you for even more important positions then.

HOW TO APPLY

If you are under thirty-five years of age, and if you have an E. E. or Physics degree, with some experience in radar or electronics,

write to:

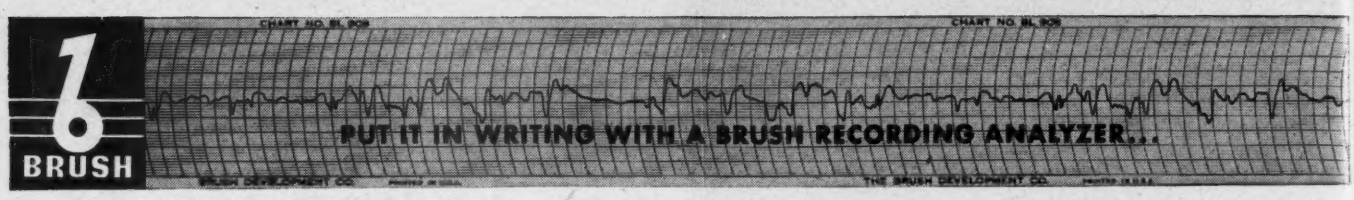
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Engineering Personnel Department

CULVER CITY, LOS ANGELES COUNTY, CALIFORNIA

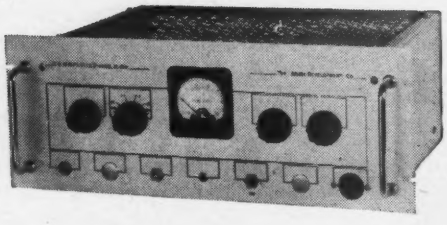
Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.



Checks dialing on Micro-wave and Carrier Current Equipment

● Brush Recording Analyzers save plotting and testing time in applications everywhere. Here, at a substation of the Bonneville Power Administration, a Brush direct-coupled dual channel amplifier and dual-channel oscillograph record dialing pulses for a maintenance check. The test immediately indicates any dialing troubles in the system, and their nature. The Brush equipment is also used to check relay operation, and has been found essential to keeping the micro-wave system "on the air". Duplicate Brush equipment is used to service communication facilities in each Bonneville maintenance area.

MEASURES ELECTRICAL VARIABLES . . . CHART AVAILABLE INSTANTANEOUSLY



Brush Direct-Coupled Amplifier for Rack Mounting, Model BL-962.

This high gain, low-drift D-C amplifier is designed for mounting in a standard 19-inch rack. Other Brush amplifiers and oscillographs are being designed for rack mounting. When used in conjunction with Brush direct-writing oscillographs, amplifier can be used to make recordings of many types of phenomena which previously required complicated intermediate equipment. Voltage gain gives one chart millimeter deflection per millivolt input. Frequency response is essentially linear from D-C to 100 cycles per second. (Bulletin F-698)

Direct-writing Two-Channel Magnetic Oscillograph Model BL-202

The Brush Magnetic Oscillograph, used with the proper Brush Amplifier, makes a direct chart recording of voltage or current, or of physical phenomena such as strain, pressure, acceleration, torque, force, temperature, displacement and vibration. Either direct inking or electric stylus models available. Gearshift provides chart speeds of 5, 25, and 125 mm per second. An auxiliary chart drive is available for speeds of 50, 250, and 1250 mm per hour. Accessory equipment provides event markers where an accurate time base is required, or where it is desirable to correlate events. Photo shows two-channel model for recording of two phenomena simultaneously.

For Bulletin 618 describing these instruments write The Brush Development Co., Dept. FF-33, 3405 Perkins Avenue, Cleveland 14, Ohio. Representatives located throughout the U. S. In Canada: A. C. Wickman Limited, Toronto.

THE *Brush* DEVELOPMENT COMPANY

BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording
Acoustic Devices
Ultrasonics
Industrial & Research Instruments

Here's what makes RAYTHEON RELIABLE SUBMINIATURE TUBES

RAYTHEON RELIABLE SUBMINIATURE TUBES

CK5702WA
RF Amplifier Pentode

CK5703WA
High Frequency Triode

CK5744WA
High Mu Triode

CK5783WA
Voltage Reference

CK5784WA
RF Mixer Pentode

CK5787WA
Voltage Regulator

CK5829WA
Dual Diode

CK6021
Medium Mu Dual Triode

CK6111
Low Mu Dual Triode

CK6112
High Mu Dual Triode

CK6152
Low Mu Triode

✓ **EXPERIENCE** Raytheon has been in constant, large scale production of subminiatures for fourteen years — has made millions of them.

✓ **ENGINEERING** Many Raytheon engineers have worked exclusively on the development and improvement of Subminiature tubes. Raytheon designs have proved themselves in the field.

✓ **EQUIPMENT** Raytheon's production, testing and inspection facilities are custom built. Improved welding, sealing and exhaust procedures are among the many exclusive Raytheon advances.

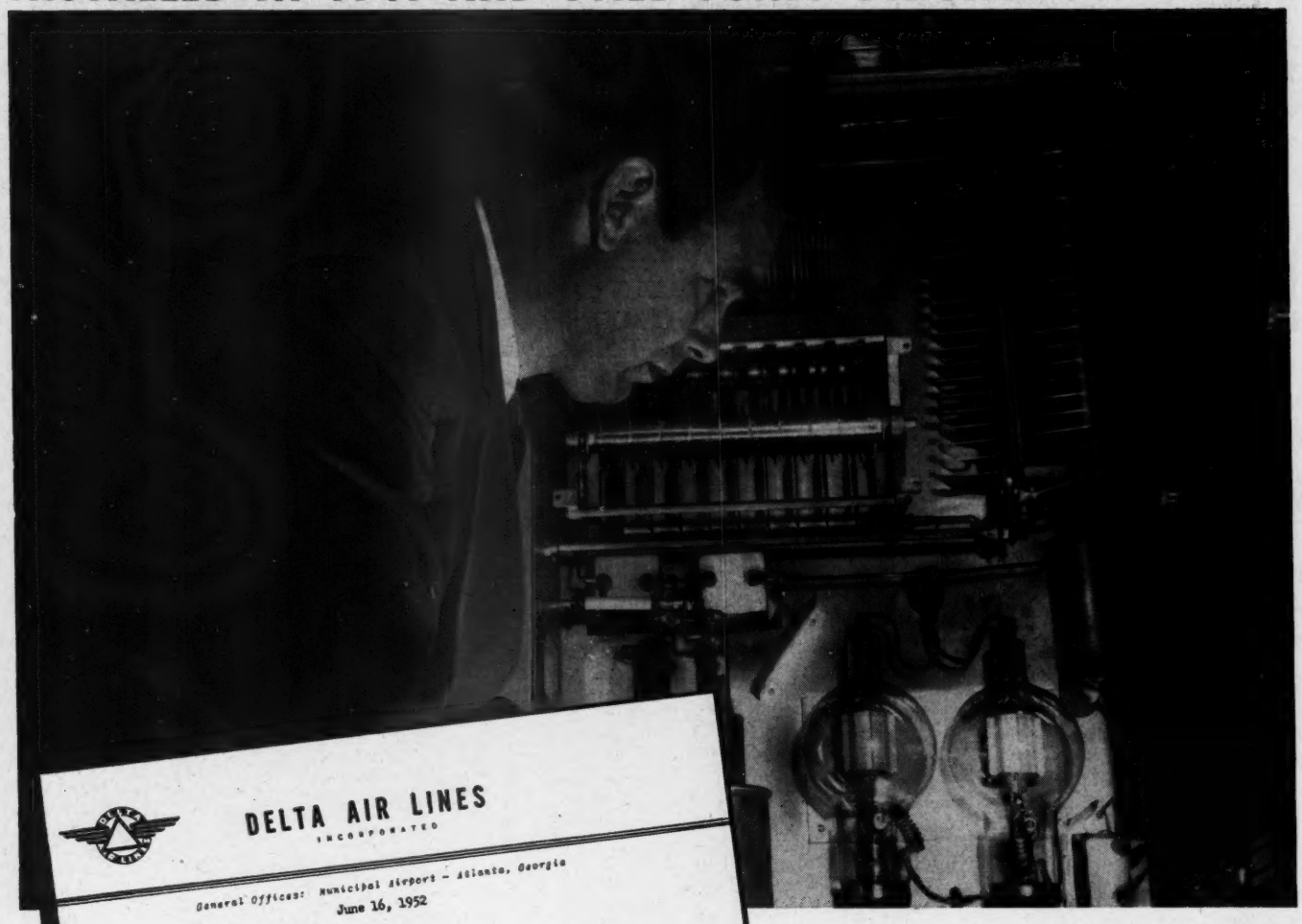
✓ **EXCLUSIVE SUBMINIATURE TECHNIQUES** Include closer production tolerances for all parts; separate production and inspection personnel free of production-incentive pressure; grid inspection with high optical magnification; microscopic inspection of each assembly; longer, more complete electrical aging; rigid tests for shock, vibration, acceleration and all other factors affecting performance and life.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

RAYTHEON MAKES ALL THESE:

INSTALLED IN 1941 AND STILL GOING STRONG...



DELTA AIR LINES
INCORPORATED

General Offices: Municipal Airport - Atlanta, Georgia

June 16, 1952

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

From time to time in your advertisements, I have noticed reports of Eimac tubes that have served an exceptionally long life. You may be interested in the 450TL statistics at our Atlanta, Georgia, station.

The transmitter in this station uses eight 450TL's in RF service. Of the eight, seven have been in operation since the transmitter was installed in October, 1941. Our Dallas, Texas, transmitter installed about the same time still has five of its original 450TL tubes.

The most important factor in the operation of an airline is safety. This is determined largely by the dependability of the equipment it uses. Delta Air Lines, like any business operating on a sound financial basis, must obtain the most value for every dollar spent. It would appear, in the case of our radio tubes as well as many other products, that the two factors, safety and economy, go hand in hand.

Very truly yours,

DELTA AIR LINES, INC.

J. B. Kramer

J. B. Kramer
Supervisor of Ground Radio

JBK:dg

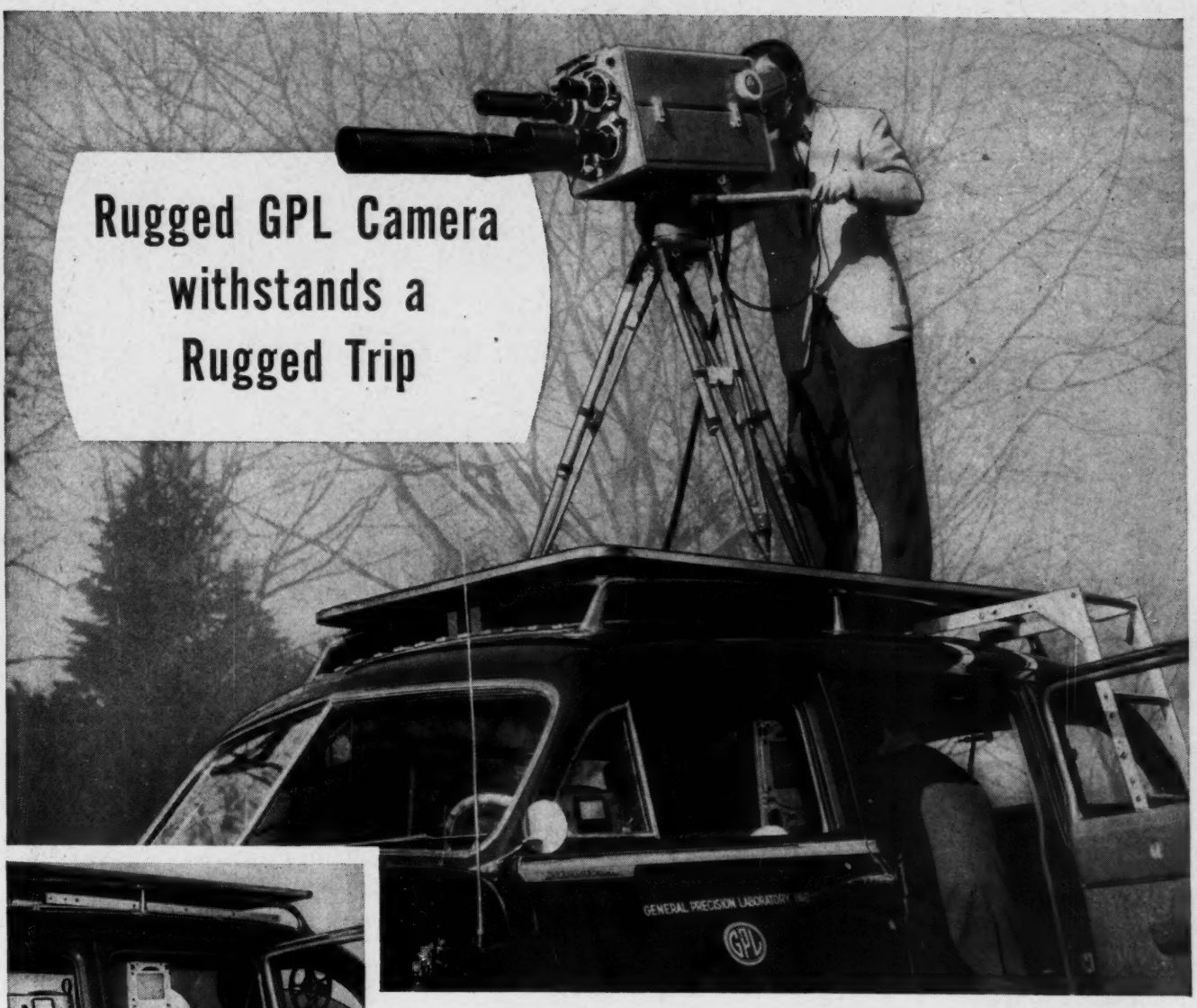
. . . reports DELTA AIR LINES of EIMAC Tubes

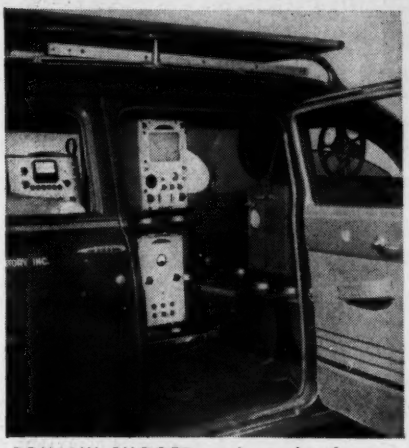
This story of dependability through more than a decade of day in, day out operation is typical of what leading users of electronic equipment are finding whenever Eimac tubes are employed. Write our application engineering department for information about the complete line of Eimac transmitting power tubes.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

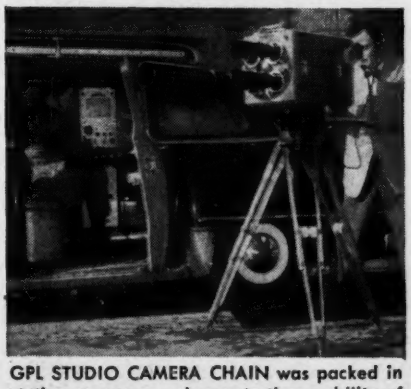
Eimac TUBES

Rugged GPL Camera withstands a Rugged Trip





EQUALLY RUGGED and service-free on trip was GPL Utility Projector with "3-2" intermittent which permits use with I. O. camera for film telecasting from remotes.



GPL STUDIO CAMERA CHAIN was packed in station wagon . . . demonstrating mobility of entire chain for fast coverage of news events, sports, other programs in the field.

20,000 Miles Cross-Country Without Camera Service

This GPL image orthicon camera has just completed a demonstration tour to studios in 67 cities from Maine to Mexico . . . Michigan to Miami.

Without a single service operation, it took the bumps of 20,000 miles of hard driving. It was loaded and unloaded more than 150 times. Every working element received far more than normal wear and tear, as usual on demonstrations. Yet nothing failed, nothing needed replacing.

This is the kind of ruggedness you may have for both studio and field operations, PLUS all the precision of GPL camera design. This unit is engineered for smooth, fast control, from pushbutton turret change to remote adjustment or iris and focus.

For the stations just starting, it has many special advantages: in compactness of chains, ease of operations.

Write, wire or phone, for full details of the camera equipment that is the "industry's leading line—in quality, in design."

General Precision Laboratory INCORPORATED **GPL**

PLEASANTVILLE NEW YORK

Export Department: 13 E. 40th St., New York, N. Y. Cable address: Arlab

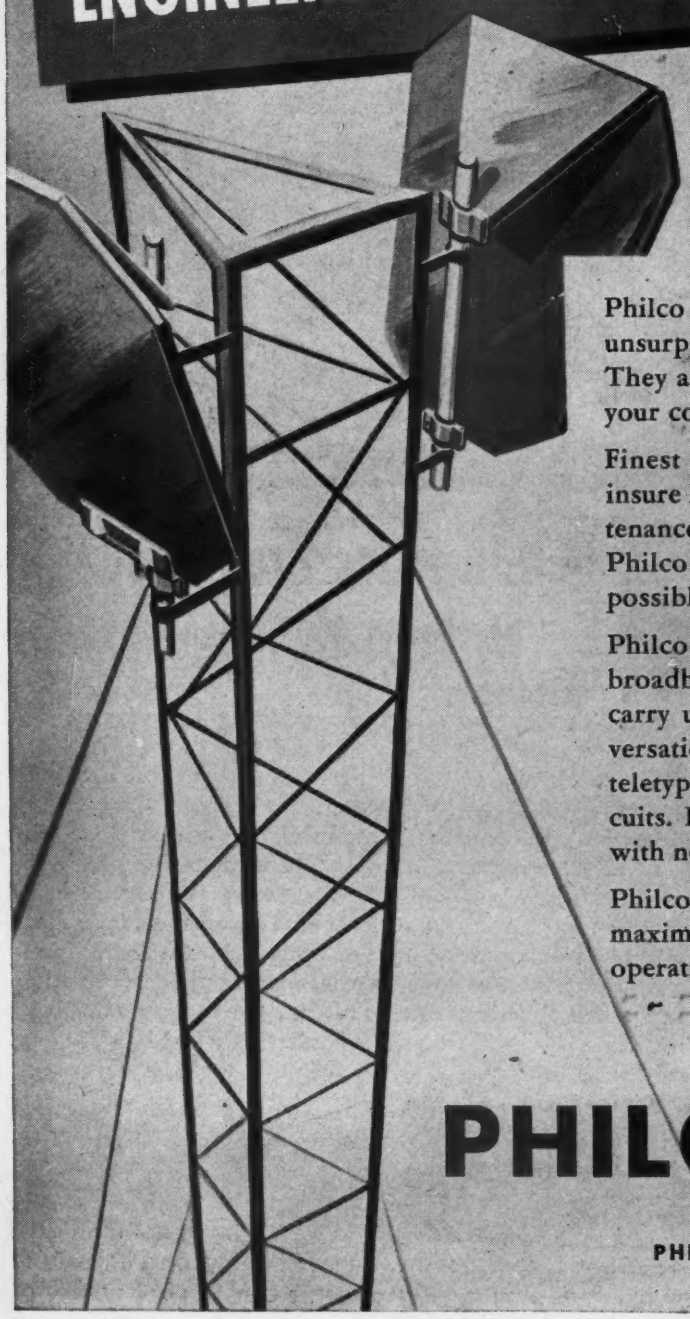
TV Camera Chains • TV Film Chains • TV Field and Studio Equipment • Theatre TV Equipment

PHILCO

Advanced Design MICROWAVE

COMMUNICATIONS SYSTEMS

ENGINEERED FOR GREATEST ECONOMY!



Philco *Advanced Design* Microwave Systems are unsurpassed in reliability, performance and economy. They are designed to give you the greatest value for your communications dollar!

Finest quality components, conservatively rated, insure long life and economy of operation and maintenance. Years of production experience enable Philco to produce microwave systems for the lowest possible cost consistent with highest quality.

Philco *Advanced Design* Microwave is flexible. The broadband microwave channel may be divided to carry up to 24 simultaneous 2-way telephone conversations . . . or be further divided for telegraph, teletype, telemetering, signaling or supervisory circuits. Future expansion can be easily accomplished with no loss of original investment.

Philco *Advanced Design* Microwave Systems give you maximum reliability . . . plus *low cost* installation, operation and maintenance. *Don't settle for Less!*

PHILCO CORPORATION

INDUSTRIAL DIVISION

PHILADELPHIA 34, PENNSYLVANIA

ENGINEERING

PLUS

CRAFTSMANSHIP

SOLVED

THIS UNUSUAL

REQUIREMENT

THE PROBLEM:

The problem was to develop a crystal unit for AM broadcast (550-1600 kc) which would maintain frequency tolerance per FCC requirement (±20 cycles) *without temperature control.*

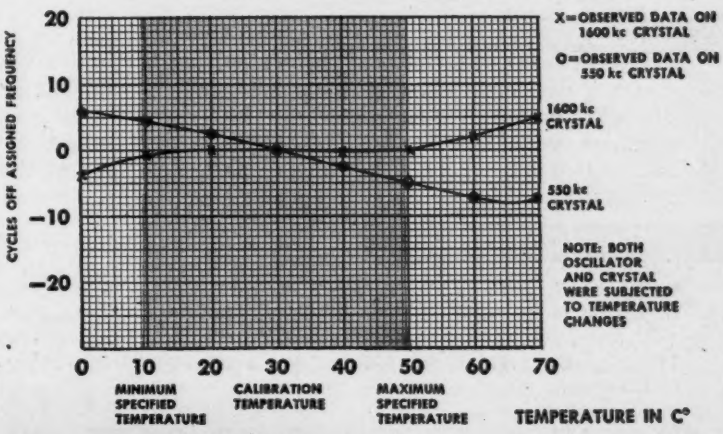
THE SOLUTION:

When designing the crystal oscillator, the transmitter manufacturer gave primary consideration to voltage stability and low r.f. current. The resultant design provided an ideal environment for realization of the inherent stability of the crystal unit employed.

Bliley designed a plated crystal utilizing precision orientation to achieve the low drift characteristic needed. Contrary to ordinary practice in this frequency range, the crystal was soldered between rigid supports to prevent frequency deviation due to physical displacement. The assembly was then hermetically sealed in a dry nitrogen atmosphere to prevent contamination and minimize aging.

The resultant production units,type BH8, are calibrated at 30°C with maximum deviation not exceeding ±10 cycles thru the temperature range from +10°C to+ 50°C.

TYPICAL STABILITY DATA



Bliley CRYSTALS

BLILEY ELECTRIC COMPANY · UNION STATION BUILDING · ERIE, PA.

• DIRECT READING • RAPID CYCLING • LOW COST

PRINTED READOUT for high speed electronic counters is now available at low cost as a standard BERKELEY product! This Digital Recorder provides a direct means of permanently recording sequential count information in arabic numeral form on a standard adding machine tape. It is designed to operate from electronic counters, Time Interval Meters, Events-per-Unit-Time Meters, nuclear scalers, and other electronic totalizing devices. Most standard BERKELEY instruments now in use can be readily adapted for operation with the BERKELEY Series 1550 Digital Recorder, thus eliminating the need for purchase of new counting equipment.

DIGITAL RECORDER . . . Series 1550 is composed of a Readout unit and a Printing Recorder. The first unit consists of a bank of readout decimal counting units essentially paralleling the totalizing function of the basic counting instrument from which they operate, and a selecting relay matrix to channel information from the counting circuit to the Printing Recorder. This second unit presents a sequence of total counts in direct reading digital form on a standard adding machine tape.

A COMPLETE SYSTEM . . . of Electronic Counter and Digital Recorder then consists of three elements: a suitable electronic counting device, Readout unit, and Printing Recorder. The latter two elements comprise the complete Digital Recorder. Under certain conditions a special modification of the system will permit original count information to be channeled directly into the Readout unit, thus eliminating the need for a separate electronic counter.

SPECIFICATIONS . . . Minimum counting period determined by the characteristics of the basic counting instrument. Maximum cycling rate: 1 printout every ¾ second. Indicating capacities 3, 4, 5 or 6 columns. Readout Unit—20¾" x 10½" x 15" cabinet, wt. 60 lbs., standard 19" relay rack panel. Printing Recorder—7½" x 8¼" x 14½" cabinet, wt. 20 lbs. Price, Digital Recorder, Model 1553 (3-column), $1050; Model 1554 (4-column), $1125; Model 1555 (5-column), $1200; Model 1556 (6-column), $1275, f.o.b. factory.

M-2

Please request Bulletin 810

Berkeley Scientific

division of BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVENUE • RICHMOND, CALIFORNIA

"DIRECT READING DIGITAL PRESENTATION OF INFORMATION"

TELE-TIPS

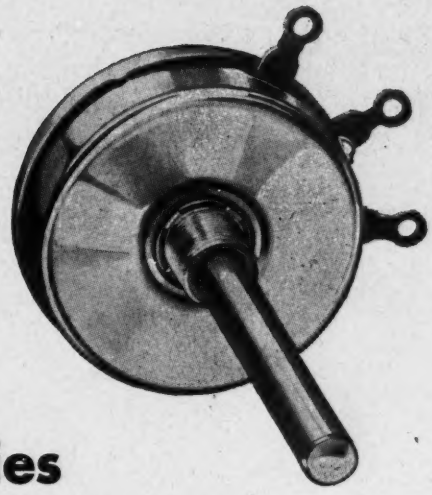
LOOK FOR a new style in horizontal output transformers for television receivers. Latest word from designers is that adjustable cores will be used to provide width control in lieu of the old width coil, or potentiometer width control which recently came in favor. Shades of the good old days of radio when we had adjustable transformer cores! Once again the radio cycle repeats!

SUPERCONDUCTIVITY of metals and crystals is proving itself a promising field of application for scientists engaged in extremely low temperature research. Some 50 laboratories are presently involved in ultra-cold investigations. Also, an exceptionally hard stainless steel was the outgrowth of one experimental study which immersed the metal in liquid nitrogen at -320° F.

NOISE RECORDING of power transformers operating in the field is another application of the versatile magnetic tape recorder. GE engineers, using a Magnecord tape recorder, have found that by recording transformer hum and analyzing the data in the laboratory, they obtain better results than by transporting the lab equipment to the operating site. The new method makes two-minute recordings of sound level meter output for various microphone locations. Every 15 minutes a standard sound is recorded for calibration purposes. An additional advantage is that playback in a known amount of laboratory ambient noise permits subjective judgment of less tangible aspects of apparatus noise.

AIR-TECH INTELLIGENCE—A little known department—and naturally so, of the Air Force, is Air Technical Intelligence at Wright Field. Here the secrets of enemy electronic equipment are extracted from piles of seeming junk which have been brought back from Korea and other areas. A development of military intelligence of World War II, this division has fingers in literally all corners of the earth, and generally speaking, it is not long before the boys at Wright Field learn what makes the latest enemy radio equipment operate.

Built for the toughest service....



Mallory Q Series Wire Wound Controls

If you need a wire wound control that will stand up under the most severe conditions, here's the answer to your problem—Mallory Series Q controls. These new features make the Q series your best choice for military and other exacting applications:

IMPERVIOUS TO MOISTURE AND FUNGUS: all insulation used in this control is made of high resistance material which has exceptionally low moisture absorption . . . treated to prevent fungus growth.

WEATHERPROOF FINISH: nickel plated case, stainless steel shaft, and all other metal parts will pass a 100-hour salt spray test.

LONGER LIFE: hard nickel-silver contacts withstand the wear of thousands of rotations.

SELECTION OF TAPERS: all standard JAN tapers are available.

In addition to these standard features, Q series controls can be supplied in a number of special variations invaluable in applications requiring complete waterproofing or extreme resistance to vibration:

WATERPROOF SHAFT BUSHING: a waterproof gasket between shaft and bushing, sealed with silicone grease, prevents leakage along the shaft.

WATERPROOF PANEL SEAL: gasketed seal prevents leaks at the point of panel mounting.

BUSHING LOCK: a split bushing, when tightened, prevents shaft rotation even under severe shock and vibration.

New Technical Bulletin Number 76-3 includes complete details on Mallory wire wound controls. Write for your copy.

Series	Watts	Diameter	Similar JAN Type
QC	2	1⅛"	RA15
QR	2	1¼"	RA20
QM	4	1⅜"	RA25 & RA30

P. R. MALLORY & CO. Inc.

MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
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SILECTRON C-CORES...BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

W&D 4363

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

THE ARNOLD ENGINEERING COMPANY

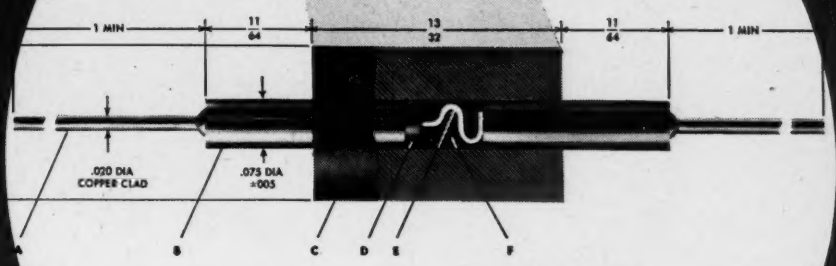
SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

ACTUAL SIZE

New CBS-HYTRON Germanium Diodes

Guaranteed Moisture-Proof!



Mechanical Specifications

A. .020" copper-clad wire
B. Nickel-silver "clip-in" pin
C. Glass-filled plastic case
D. Germanium crystal soldered directly to base
E. .005" tungsten cat whisker
F. Moisture-resistant impregnating wax

GENERAL PURPOSE TYPES

1N48
1N51
1N52
1N63
1N64
1N65
1N69*
1N70*
1N75
1N81*

*JAN TYPES

WHY CBS-HYTRON GERMANIUM DIODES ARE BETTER RECTIFIERS

1. ***MOISTURE-PROOF*** . . . eliminates humidity and contamination problems
2. ***SELF-HEALING*** . . . self-recuperating from temporary overloads
3. ***SUBMINIATURIZED*** . . . only ½ inch long, ¼ inch in diameter
4. ***SOLDERED WAFER*** . . . omission of plating eliminates flaking
5. ***LOW SHUNT CAPACITY*** . . . 0.8 μμfd average
6. ***SELF-INSULATING CASE*** . . . mounts as easily as a resistor
7. ***EXCEPTIONAL LIFE*** . . . 10,000 hours minimum under rated conditions
8. ***NO FILAMENTS*** . . . low drain, no hum

Vital germanium wafer in a CBS-Hytron diode is *guaranteed moisture-proof.* Sealed against deadly moisture . . . fumes . . . and contamination, a CBS-Hytron diode keeps moisture where it belongs . . . out! First, by a chemically and electrically inert impregnating wax. Second, by a glass-filled phenolic case. With *moisture-proof* CBS-Hytron germanium diodes, you can be sure of maximum trouble-free life.

Superior techniques also permit CBS-Hytron to omit plating of the germanium wafer. Soldering is directly to the base. Thus flaking is eliminated and quality improved. Universal design of CBS-Hytron diodes follows Joint Army-Navy specifications. "Clip-in" feature gives you versatility, ruggedness, and electrical stability. Flexible pigtails of copper-clad steel welded into sturdy nickel pins also insure you against damage by soldering heat.

Check the eight important-to-you reasons why CBS-Hytron *moisture-proof* germanium diodes are better rectifiers. Send today for complete data and interchangeability sheets. Specify CBS-Hytron *guaranteed moisture-proof* diodes for superior, trouble-free operation.

CBS HYTRON RADIO TUBES

HYTRON
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.
SALEM, MASSACHUSETTS

Accurate — Portable — **AVAILABLE**

Gold Plating of the oscillator cavity and tuning plunger assures smooth action and reliable performance over long periods. Generous use of silicone-treated ceramic insulation, including resistor and capacitor terminal boards, and the use of sealed capacitors, transformers, and chokes, insures operation under conditions of high humidity for long periods.

The Type H-12

UHF SIGNAL GENERATOR

900-2100 Megacycles

This compact, self-contained unit, weighing only 43 lbs., provides an accurate source of CW or pulse amplitude-modulated RF. A well-established design, the Type 12 has been in production since 1948. The power level is 0 to −120 dbm, continuously adjustable by a directly calibrated control accurate to ±2 dbm. The frequency range is controlled by a single dial directly calibrated to ±1%. Pulse modulation is provided by a self-contained pulse generator with controls for width, delay, and rate; or by synchronization with an external sine wave or pulse generator; or by direct amplification of externally supplied pulses.

Built to Navy specifications for research and production testing, the Type H-12 Signal Generator is equal to military TS-419/U. It is in production and available for delivery.

Price: $1,950 net, f.o.b. Boonton, N. J.

Type H-14 Signal Generator

(108 to 132 megacycles) for testing OMNI receivers on bench or ramp. Checks on: 24 OMNI courses, left-center-right on 90/150 cps localizer, left-center-right on phase localizer, Omni course sensitivity, operation of TO-FROM meter, operation of flag alarms.

Price: $942.00 net, f.o.b. Boonton, N. J.

ARC **Aircraft Radio**
CORPORATION — BOONTON, N. J.

WRITE TODAY for descriptive literature on A.R.C. Signal Generators or airborne LF and VHF communication and navigation equipments, CAA Type Certificated for transport or private use.

Dependable Electronic Equipment Since 1928

"G-E TUBES HELP US GIVE CLEVELAND DEPENDABLE TV!"

Says **THOMAS B. FRIEDMAN**
Chief Engineer, WXEL—Cleveland

"OUR AUDIENCE is loyal, because—for one thing—WXEL programs rarely are interrupted by transmission failures. Part of the reason is G-E tube dependability. Rectifiers, power tubes, receiving types: all these G-E tubes keep doing their rated job once we install them—don't fail unexpectedly, 'blacking out' our signal without warning.

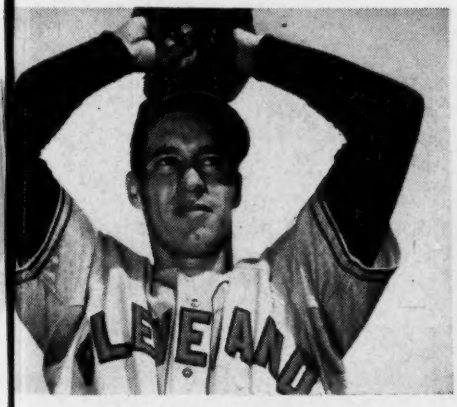
"I'd like to say something about service, too. When we need a tube, G-E distribution goes all-out to get it to us fast. Their service day is 24 hours long. If a critical power tube arrives in the city by plane at 11 P.M., G.E. gets it to us from the airport before midnight!"

★ ★ ★

Thanks for your praise of G-E tube dependability and service, Mr. Friedman. General Electric is glad to have contributed to WXEL's success.

Station engineers everywhere can rely on (1) reliable G-E tube performance, (2) fast deliveries, (3) help from local G-E distribution in obtaining—by sound conservation measures—long life and high value from tubes in service. Benefit from these plusses. Get in touch with *your* nearby G-E tube distributor today.

AVAILABLE TO STATION ENGINEERS—"Essential Characteristics," a pocket guide to all receiving tubes in common use. Ask your G-E tube distributor for this convenient, useful reference book! Or write to *Section B, Tube Dept., General Electric Company, Schenectady 5, N. Y.*



TELECASTS ALL INDIAN HOME GAMES

To thousands of Cleveland baseball fans, WXEL takes first place in video as a result of putting Indian home games on the air. Good mobile facilities also enable the station to cover all other local events of importance. Cleveland viewers have come to rely on WXEL for their spot pictorial news, and high-quality unbroken transmission—to which G-E tubes contribute—plays a key part in maintaining station popularity.

You can put your confidence in—

GENERAL ELECTRIC

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American offers you the "Full-Vision" line of quality microphones, a complete line for television and radio broadcast—AM and FM, motion picture studios, professional and home recording, and public address.

Pioneers in the design and manufacture of quality microphones, American has also pioneered the introduction of quality microphones that are designed to be . . . *HEARD AND NOT SEEN.*

Attractive "Full-Vision" styling permits both the artist and the audience to enjoy perfect performance without obstructing the view.

FULL VISION

For greater fidelity . . . plus . . . "Full-Vision" for artist and audience . . . use American.

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American MICROPHONE CO.

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LETTERS . . .

BBC for TransAtlantic TV

Editors TELE-TECH:

I have read with interest your proposal that the possibilities of trans-Atlantic television should be further considered.

The BBC looks forward to the day when a television link across the Atlantic will be a reality because this will make possible an interchange of programmes between the BBC on the one hand and the American networks and Canada on the other. The technical difficulties are very great, and the cost of an acceptable scheme is bound to be high. Nevertheless these problems are certain to be solved.

H. BISHOP
Director of Techical Services, BBC.
Broadcasting House,
London W1.

TV Audience Limitation on VHF and UHF

Editors TELE-TECH:

I have read with much interest your editorial "Let's Take a Careful Look at Subscription-TV." Assuming for the moment that a subscription-TV service would be successful from an economic standpoint, the question is whether or not as a matter of public policy the Federal Communications Commission can be prevailed upon to provide for this type of service in its Rules and Regulations. While this is a policy question, nevertheless important factors affecting the answer are very likely to be those based upon engineering and allocation considerations. Therefore, the comments of an engineer may have some value.

There are only 12 VHF television channels. The Commission's Rules and Standards with respect to station separations applicable to these 12 channels are such that the number of available services in most areas is severely limited. Forty-one large cities and adjacent areas have only one VHF television assignment; 8 cities have only two, and 9 cities have only three. There are quite a few cities of substantial size which have no VHF television assignments.

The policy with respect to sound broadcasting has always been that broadcast programs must be available to any listener at no cost except that involved in the purchase of a radio receiving set. The same policy exists with respect to television broadcasting. The inauguration of a subscription television service on any one of the VHF channels would limit the availability of programs to those willing to pay a subscription charge. In vew of the inherent severe limitation with respect to the availability of television service which already exists, it is difficult to see how the agency charged with regulation of broadcasting in the public interest could be prevailed upon to permit a type of

(*Continued on page* 30)

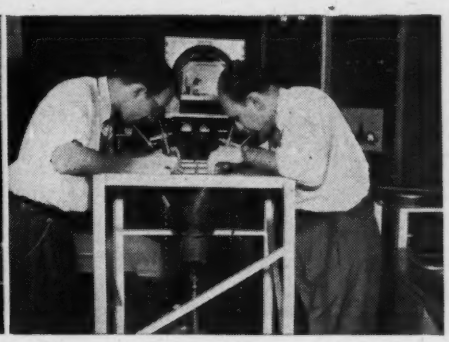
What Rauland means by "Perfection Through Research"

Rauland is one of the few companies devoting so much top engineering talent full time to picture tube improvement and perfection.

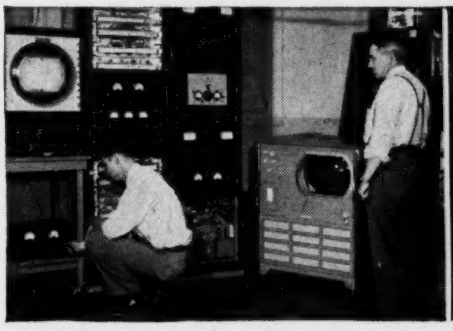
The result has been to give you more picture tube advancements since the war than any other manufacturer . . . first chance at the latest developments for companies using Rauland tubes as original equipment . . . and a real selling edge at the retail level because of the extra satisfaction which Rauland advantages offer.

That's why so many alert manufacturers look to Rauland for the best in picture tubes.

Rubber model for studying electron optical designing—basis for Rauland's exclusive Indicator Ion Trap.

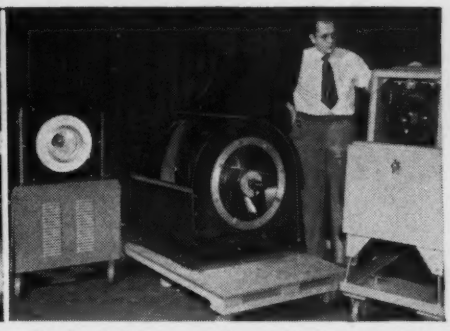


Alignment of the screen and parallax mask of tri-color tube containing approximately a million fluorescent dots.

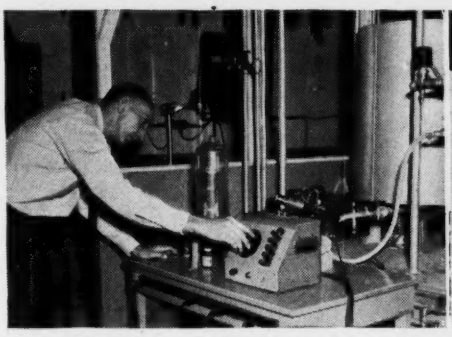


All-electronic tri-color tube in electronic receiver system (left) in comparison with mechanical system (right).

Inspection and checking of perforations .0075" in diameter in masks of tri-color picture tubes.

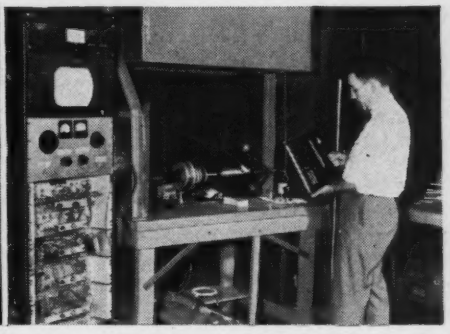


Rauland large-screen projectors using three different optical systems, all of which give theater-size pictures.



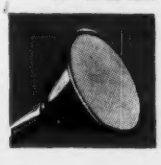
Careful study of the formation of thin metallic films in a vacuum . . . basis for the aluminizing of tubes.

Examination with polarimeter permits careful control of strains for superior glass-to-metal sealing.



A physicist using a Rauland-developed radiation meter in checking X-ray radiations from cathode ray apparatus.

THE RAULAND CORPORATION



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For more than 25 years, Kenyon has led the field in producing premium quality transformers. These rugged units are (1) engineered to specific requirements (2) manufactured for long, trouble-free operation (3) meet all Army-Navy specifications.

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Products containing CLEVELITE are in use the world over.

Possibly right now we can be of service to you through our Research and Engineering Laboratory on some new product, or in helping you to improve performance and lower costs.

Yes, Clevelite will be made to your exact specifications, meeting the required tolerances.

Clevelite assures you of uniformity and continued, dependable performance at lower production costs.

Hundreds of thousands of Clevelite coil forms, collars, bushings, spacers, tubes and other items are giving continuous satisfaction. Play safe! Be sure you use CLEVELITE!

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CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

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Electric Soldering Irons are Service Proven...

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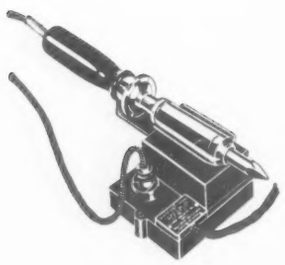

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Thermostatically controlled to maintain heat of Iron at any desired temperature while at rest.

- Nickel-coated, corrosion-resistant tips, easily and quickly replaced
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- Heating element of chrome-nickel ribbon resistance wire
- Insulated with pure mica
- Built-in adapter for ground wire

WRITE FOR FREE LITERATURE

A-102

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICHIGAN

LETTERS

(*Continued from page* 26)

operation which would still further restrict the availability of service by requiring the listener to pay for it.

The above comments with respect to the future of subscription TV appear logical to me as an engineer insofar as VHF channels are concerned. Just what future subscription TV might have on the UHF channels is something else again. There are more UHF television channels than VHF channels. Because of economic and other considerations, demand for UHF channels for general television broadcasting is not as yet nearly so great as for the VHF channels. Therefore, it might be that the same reasons for prohibiting subscription television on VHF channels would not apply to UHF channels.

C. M. JANSKY, JR.
Jansky & Bailey, Consulting Engineers
National Press Bldg., Washington, D.C.

Development of 450-470 MC Mobile Band

Editor, TELE-TECH:

Your article by Robert E. Tall in the August issue, page 47, on the subject "Mobile Radio Looks to UHF" fails to give any credit to the writer who has pioneered this 450-470 MC frequency spectrum for the past three years.

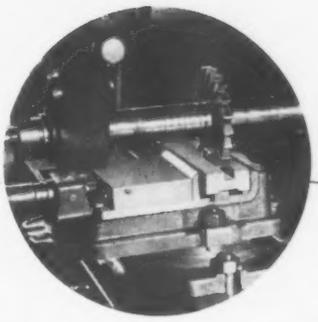
Every 2-way radiotelephone system in operation today was surveyed, sold and installed under my direction and the installations in New York, Newark, Chicago, Detroit, Baltimore and San Francisco which formed the basis for the National Utilities Radio Committee report were made by me using Link 450-470 mc equipment developed under my direction. We have over 600 mobile units in regular service for Checker Cab, Detroit—Yellow and Checker Cab, Chicago—20th Century Cab, Newark—Broadway Maintenance Corp., Long Island City, New York and Pittsburgh, Pa.—New York Daily Newspaper, New York City—Consolidated Gas & Electric Co., Baltimore, Pennsylvania Bell Telephone Co., Philadelphia, Pa.—Canadian Marconi Co.—Montreal, Canada—Paris, France Police Department—Palo Alto California Police Dept.—Welsbach Company, New York City—U.S. Signal Corps., Fort Monmouth, New Jersey—U. S. Air Force.

Pioneers seem to get little credit for their efforts but at least we can keep the records straight.

One Fifth Ave.
New York 3, N. Y.

NORMAN E. WUNDERLICH
Consulting Engineer

TRANS-ATLANTIC TV is predicted within a decade by Dr. W. B. Engstrom, director of RCA's Princeton laboratories. Speaking before the Centennial of Engineering at Chicago, he said that to string repeater stations across the ocean would be too expensive, but a fleet of fast cargo planes, running on close schedule, might well carry the relay transmission equipment.



At your service

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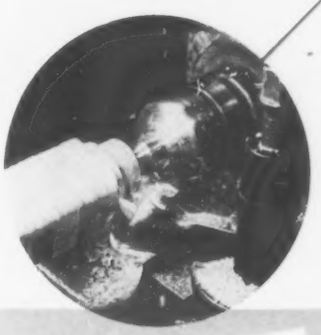

First objective in our fabricating service is to save you time, money and production headaches. Second objective is to make the service useful, but economical. Adequate facilities, modern laboratory plant and equipment, technical skills and the knowledge gained through 79 years of experience all play a part in helping us meet these objectives. Hundreds of successful customer case histories form our record. Next time you need fabricated parts—one or one million—whether of National Vulcanized Fibre or Phenolite laminated plastic, get in touch with National. We're at your service.

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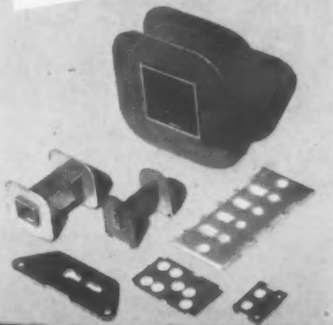

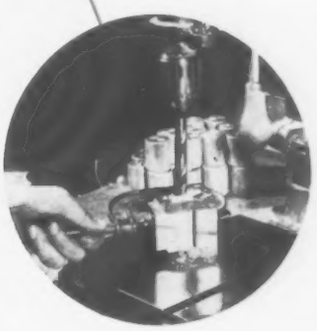

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TELE-TECH
& ELECTRONIC INDUSTRIES—RADIO-TELEVISION

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

A 19-Step Outline to Aid

Military Deferment for Key Engineers

Although more than a million men have been drafted since the outbreak of the Korean War, this is still not enough and a heavy call on Selective Service by the Pentagon will continue. Pentagon officials have disclosed that inductions must continue indefinitely at the rate of about 600,000 men per year for our "peace-time" armed forces.

Congress has extended the authority to draft men between the ages of 18½ and 26 for 2 years' active military service. Military men say that even after 1955 there is little chance that the military can cut back its demands on the American manpower pool.

This can only mean a tightening up with respect to deferments. It becomes even more important for employers requesting occupational deferments for their personnel to present the facts fully.

Engineering Manpower Commission's Recommendations

With this in mind the Engineering Manpower Commission of Engineers Joint Council, Engineering Societies Bldg., New York 18, New York, points to a 19-step outline to aid employers in preparing requests for deferments for their key engineers and scientists. This outline was prepared by the Scientific Advisory Committee of the Selective Service System, and has been circulated to local boards through Volume II, Number 7 of the bulletin of the Selective Service System. The "Outline for an Occupational Investigation," as it is called, follows:

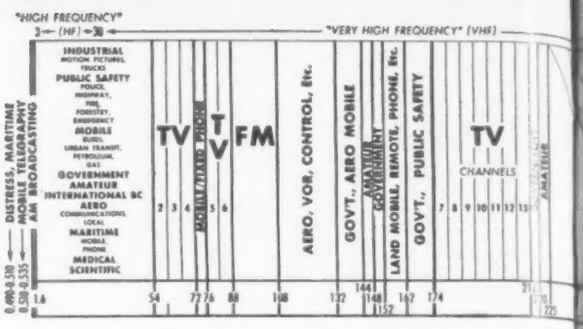
(1) What is the training and educational history of the registrant? Where did he stand in his class (if information is available?)
(2) What was his employment experience prior to job with present employer?
(3) What was the nature of his previous job assignments with present employer?
(4) What are his employment assignments on present job?
(5) What is the size, nature, and function of the group registrant is assigned to as a worker?
(6) What is the registrant's function in the group?
(7) What are the products on which the registrant is working and what is their end use? If he is not working on a product, what are the services in which he is engaged?
(8) What is the relation of these products or services to national health, safety, and interest?
(9) What is the relation of these products or services to defense or mobilization?
(10) What is the range of salaries on this job and what is the average salary of comparable employees? What is the salary of the registrant?
(11) What is the frequency with which nonprofessional personnel are hired in a similar category?
(12) Is a formal period of training customary for the job? What is its scope?
(13) How long does the training program last?
(14) If the registrant is on a training program, how long has he been on it?
(15) What is the registrant's effectiveness in relation to his fellows?
(16) What success and/or difficulties has the employer encountered in recruiting for the registrant's type of job?
(17) What are the shortages or overages in this category of employment in the registrant's plant? Nationally?
(18) If classified previously in II-A, how long has he been so classified?
(19) To what extent has the employer already lost employees to the Armed Services in the category of the registrant?

Were such information supplied originally to the local board, it would enormously simplify the process of classification, particularly with reference to II-A. In a difficult case probably nothing can take the place of the expert knowledge of a specialist as to the skill of the registrant and the importance of his functions. But there are few such cases compared with the number which would be readily decided on the basis of adequate information available to the local board.

EMC also reminds employers of the necessity for appealing adverse decisions received with respect to occupation deferments. For unless the employee is valuable enough for an appeal to be made, then it is most probable that no deferment should have been requested in the first place.

RADARSCOPE

Revealing Important Advances Throughout the Spectrum of Radio, TV and Tele Communications



REARMAMENT

NAVY COMPONENTS DEVELOPMENT—The most important current problem of the Navy Bureau of Aeronautics in its meeting of the electronics-radio requirements for naval aviation, it was authoritatively reported to TELE-TECH, is that the application of electronics has proceeded at a far greater pace than component development, to maintain some degree of overall reliability. During the current fiscal year (running from July 1, 1952 to June 30, 1953) naval aeronautics procured approximately 90 complete major items of radio and radar equipment from 75 different manufacturers by prime contract. For airborne equipment the Navy Bureau of Aeronautics is procuring during the current fiscal year $255 million of radar apparatus and $98 million of radio equipment. Major effort by the Navy, as well as the other armed services, is being made to reduce the lead time in the production and delivery of electronic-radar-radio equipment.

UHF-TV

PORTLAND, ORE., ON AIR WITH UHF-TV—Here's the transmitter of NBC's famous old Bridgeport, Conn., UHF experimental station which, in a whirlwind deal, Herbert Mayer, president of Empire Coil Co., purchased, along with its tower, and rushed to Portland, Ore., where it was quickly installed and went on the air as KPTV, first UHF station to begin regular broadcasting. Russ Olsen, KPTV's chief engineer, is at control desk; NBC engineers Bill McAllister and Vic Bary, stand by.

MILITARY AVIATION

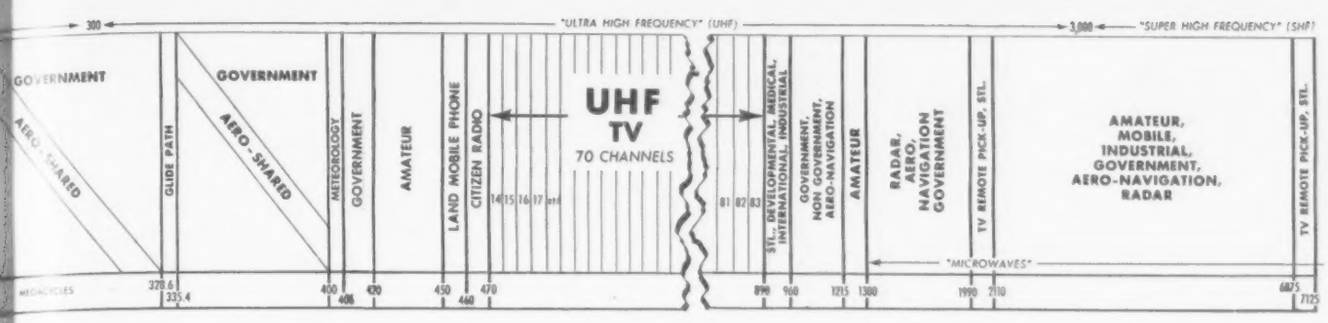
AUTOMATIC FIGHTERS. The vital role that electronic control plays in today's air operations is exemplified by the Lockheed F94 *Starfire*. It carries 1200 pounds of electronic equipment compared to the 168 pounds of radio equipment in the Lockheed P-38 which was in service only ten years ago. Night fighters of World War II had automatic fire control equipment which was designed to fire their guns when the enemy aircraft was in range, but today's *Starfire* fighter carries as much navigational equipment as a modern air liner. The radar equipment in the aircraft will locate the enemy bomber, guide the aircraft to within opening range, and discharge deadly rockets when in proper firing position—all without the pilots ever seeing their target.

AUDIO

"ROUND SOUND"—British radio listeners may soon be talking of "three-dimensional," "stereophonic," or "round" sound. "Through it, instead of getting your radio program from a hole-in-the-wall, you will have the impression that one end of the room where you listen is a concert platform where the artists are performing. If a piper is walking up and down, as he plays before the microphone, he will seem to be walking up and down in your home." The foregoing is the excited report of a British journalist after visiting the London Radio Show. Continuing he says: "The demonstration was so startlingly real that a woman in the audience publicly declared her belief that the music she had heard came from a piano hidden behind a drape. To satisfy her, the drape was lifted and she saw a tape-recording machine playing back the music through two 30-watt British-made amplifiers. In the United States, similar two-channel AM/FM demonstrations were made recently in the Middle West. And a similar stereophonic test is planned in New York by WQXR-AM-FM during the Audio Fair of '52.

MOTION PICTURES

FILMS FOR TV—The advent of magnetic striping on 16mm film opens the way to many dual-purpose uses for this motion-picture stock. Apart from its obvious use in turning old silent prints into sound prints by the simple addition of a magnetic stripe along the film, it has also doubled the usefulness of sound films which are used in bilingual markets. Prior to the introduction of magnetic striping it was necessary to make two different sets of film prints, one for English and one for the foreign language. With the advent of sound striping and half-width optical tracks it now becomes possible to have two different sound tracks on one film! In practice, the



standard optical sound track is reduced one-half, and a magnetic stripe laid over the blanked half of the optical track. The original sound track is still available for reproduction by normal photo-electric means, and the second language can be recorded on the magnetic stripe and reproduced by magnetic methods in the motion picture projector. An even more attractive use of magnetic striping and half-width optical tracks is in the preparation of prints for use in motion-picture theatres and over television. Due to the control which the musicians' union has over music for motion pictures it is, in most cases, economically unfeasible to use music in motion pictures and for television use. By use of this split track it is possible to record all dialogue on one track with musical effects on the other. When the film is used in the theatre both tracks are reproduced, and when used over television only the dialogue track need be reproduced, thus union restrictions are not violated. It is predicted that magnetic striping will widen tremendously the usage obtainable from single motion-picture prints.

TV RECEIVERS

PHONO JACKS FOR ALL SETS! A combined industry effort having the dual purpose of promoting music in the American home and increasing sales of all types of recorded music and recording and playback equipment was launched at New York in late September. During the meeting a combined industry committee under J. A. Berman, Shure Brothers Inc., who respresented RTMA, was established to carry out the promotion campaign. One phase of the program is aimed at promoting increased production and sales of combination receivers and phonographs and the inclusion of phono jacks in all television and radio sets.

AUDIO

MAGNETIC SOUND—The tremendous upsurge in the popularity of magnetic sound on tape for the movie industry—spurred of course, by the need for low-cost television films—has created a demand for a quick method for transferring and monitoring magnetic and photo electric tracks. Col. Richard Ranger, of Rangertone, has introduced the "Ranjola" to assist the tape-to-film editor. By use of two speakers, one on each side of the editor's head, one connected to the tape pickup and the other to the film pickup, it is possible to synchronize the tape and film within 1/200th of a second. When the two sound sources are accurately synchronized, the sound appears to come from straight ahead. If one source is heard before the other it indicates a loss of synchronization between the tape and the film.

MANUFACTURING

SMALL-ORDER EVIL is one of the troubles which continue to bedevil parts manufacturers—even more exasperatingly now than in more settled and conservative times. These limited and experimental orders come from both military and domestic-receiver sources, and many run from 10 to 50 units, presenting a production nuisance to a company accustomed to tool up for runs of 100,000 or more. But with the patriotic obligation involved for military experimentation, or the need to help out a big customer, the factory staff have to accept such tiny orders along with more reasonable runs—although the costs in time and factory-upset make such small orders expensive and loss-productive. And though such small orders are usually accepted without protest, this does not mean that there is not inside growling and grousing all along the line.

ACOUSTICS

AIR FORCE'S NEW TEST CHAMBER AT DAYTON—The anechoic chamber (Greek, "without echo"), new $35,000 facility of Wright Air Development Center, Dayton, Ohio. Physically-handicapped persons made the 4280 43-inch sound-absorbing wedges (composed of formaldehyde-treated fiberglass) which line ceiling, floor and walls. The chamber's walls, 5¼ ft. thick, contain cork, acoustic tile, dead air space, glass wool blanket and fiber-glass, and have cement exteriors. Dimensions of chamber 26 by 27 ft. Height 18 ft. A removable grid serves as flooring. During tests, all personnel, flooring and equipment, except equipment being tested, are removed from the chamber.

Design Considerations for Combination

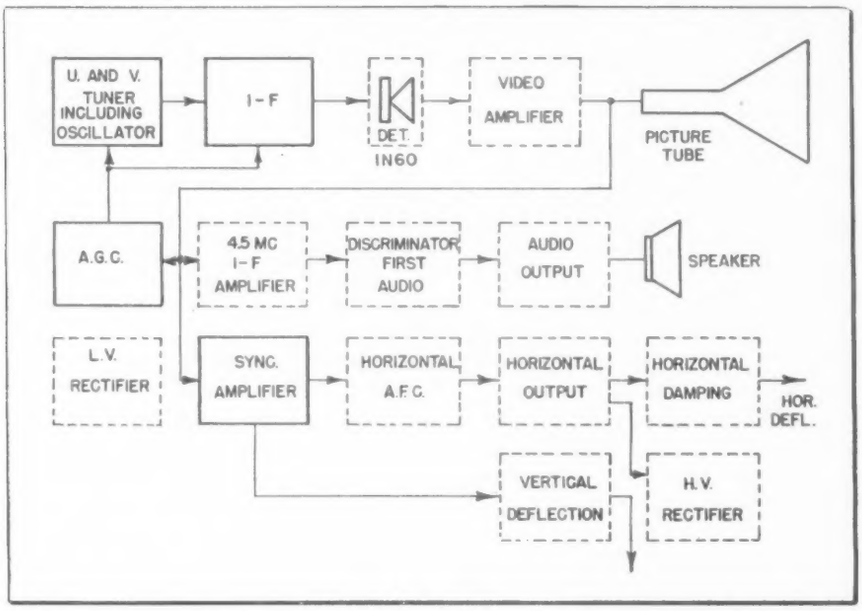


Fig. 1: Sections not requiring change in new UHF and VHF receivers are shown dotted

Circuit criteria show that several functions require change to accommodate UHF. Keyed AGC proposed to increase stability of brightness under signal fading conditions. Choice of 45.75 mc i-f explained

By
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As we view the coming large field of ultra-high-frequency television transmission, with the contemplated operation of as many as 2,000 stations, it is worthwhile to consider television receiver design to give best performance at the new frequencies.

We may first ask: what are the chief factors affecting overall design for the UHF frequencies?

It is known that the signal voltages at the receiver terminals will be lower than on VHF for similar transmitted powers and distances from the transmitter, yet the operating frequencies are such as to make good radio frequency amplifier design quite difficult. Measurements made from the Empire State Building on 910 MC in 1947[1]; by G. H. Brown[2] in Washington in 1948; and numerous field surveys of the Bridgeport Station show that for the same fringe area reception as on 60 MC, from 100 to 1,000 times the effective radiated power is required. Also, the noise factors of typical r-f amplifier circuits become worse as the operating frequency increases.

Hence, particular emphasis is immediately placed upon careful design of the input circuits of the receiver.

What, if any, are the effects upon other sections of the receiver, such as synchronizing and noise reduction? This question will be answered by discussing the overall design of a combined or composite U and V receiver.

Functions Unchanged

The standards approved for UHF transmission are the same as for VHF. Hence, there are many sections of a combination UHF and VHF television receiver whether for monochrome or color whose design will be unaffected by the new frequency allocations.

In Fig. 1, those sections which do not require change are shown in dotted outline. Because of the standardization with VHF above mentioned, the video detector, the video amplifier, horizontal AFC, deflection circuits, sound system and supply voltage sources need no basic changes. However earlier papers[3, 4] indicate the advantages of using a germanium diode, such as the type 1N60, for the video detector. It may also be of interest to discuss the characteristics of direct coupled video amplifiers and intercarrier sound operation.

High Forward Conductance

Video Detector: The germanium diode 1N60 is particularly suited to video detector application because of its high forward conductance implying low losses, and its low intrinsic capacitance and high back resistance, giving good wideband operation.

Direct Coupled Video Amplifier: Of all video amplifiers thus far analyzed, that type which is direct coupled to a negatively polarized second detector can best provide reduction in the amplitude of incoming noise pulses, so that the synchronizing amplifier receives a smaller range of undesired voltages. Such direct coupled video amplifiers provide a definite improvement in the contrast range of the reproduced picture. Also, the low video frequency response is excellent since there is no phase shift even at dc. It is to be noted that these characteristics of dc coupled video amplifiers are independent of the use or nonuse of AGC.

Intercarrier Sound: As has so often been mentioned before, the intercarrier sound system can give ease of tuning combined perhaps with less audio noise between channels. This is quite important on UHF where the great number of channels and the wide spaces between those which are active in a given location will make tuning difficult.

The block diagram indicates that the AGC, the synchronizing circuits, i-f amplifier and, of course, the tuner require modification or new design.

AGC: The AGC should be the best possible since fading can be more severe on UHF than on our present television channels. For

UHF & VHF Receivers

example, due to the sharper shadow regions—less diffusion of the wave front around obstacles,—airplane flutter can produce larger ratios of signal strength change. Some keyed automatic gain control circuits may improve the stability of the background and brightness level for both rapid and slow variations of the signal amplitude.

Synchronizing Circuits: These should also be of the best possible design to reduce the effects of rapidly fluctuating signals and such interference as may occur due to cross-modulation. Cross-modulation may occur more readily at UHF due to the poorer discrimination against nearby channels by the limited number of tuned radio frequency circuits and can produce additional synchronizing pulses with incorrect time delay.

Carrier Frequencies

The I-F Amplifier: As to be expected, an increase in carrier frequency should involve some corresponding increase in intermediate frequency in order to maintain a reasonable value of image ratio. In moving from the 54-60 MC frequencies of channel 2 to the 884-890 MC channel at the upper end of the new band, there is a change of 16 to 1 in the carrier frequencies. Fortunately, the i-f frequency does not need to go up as rapidly as the carrier frequency, since the desired channel width remains at the same 6 MC value.

TABLE I

UHF TUNER CLASSIFICATIONS

A—Continuous Tuning with Oscillator at Fundamental Frequency

B—Rotary Switch for Sectional L and C Change with "Band Spread" by Capacity Tuning.

C—Rotary Switch with VHF Oscillator and Crystal Harmonic Generator. Usually of Turret Type with Pre-Set Channels.

Methods of Tuning

1. **Movable Core—Variable L and C**
2. **"Butterfly"—Cylinder or Ring**
3. **Sliding Contact**

The intermediate frequency should be chosen for:

a. the best image rejection,
b. minimum power in the beat frequencies between harmonics of the i-f and the incoming signal,
c. minimum local oscillator radiation.

These three requirements indicate a much higher frequency than has been used in the past yet the frequency should be made as low as is feasible in order to provide:

d. low noise factor,
e. good gain for a given number of stages, and
f. avoid regeneration with the low channels of the VHF band, that is, if the frequency approaches the region of 54 MC it would be very difficult to avoid regeneration when tuned to channel 2.

It is to be noted, that going from an i-f frequency below channel 2 to one in the region of 120 MC degrades the noise factor of the i-f amplifier by at least 2 db. Also, it is easily shown that an intermediate frequency higher than channel 2, can lead to difficulties in mixer and local oscillator design for the VHF portion of the combined V and U receiver. Hence, it seems that the choice of the i-f amplifier for complete U and V tuners should be in the frequency range as close to channel 2 as is consistent with reasonable freedom from regeneration.

Now, it is clear that the i-f frequency proposed by the RTMA—41.25 for sound, 45.75 for the i-f picture carrier—is a reasonable choice. Also, this frequency range lies in a part of the spectrum where very few and only low power radio transmitters operate (with the exception of some—we hope temporary—police transmitters). Later, some of the electronic designs of the i-f amplifier will be discussed.

The Tuner

Due to the large number of channels possible between 470 and 890 MC (being 70) as compared with the twelve of the present band, there are various "schools of thought" regarding the mechanical operation of the tuner.

Mechanical Arrangements: It may be of interest to classify possible mechanical designs under three headings, shown in Table 1.

a. Continuously tunable—examples of this are DuMont, RCA, and Mallory.
b. Semi-Continuous—what may be called a "band spread" type, in which a switch chooses various zones of the UHF band and a dial actually tunes in the channels in each zone.
c. Selector Switching—where a choice of perhaps any six up to eleven UHF channels may be pre-set and then are tunable along with 7 or

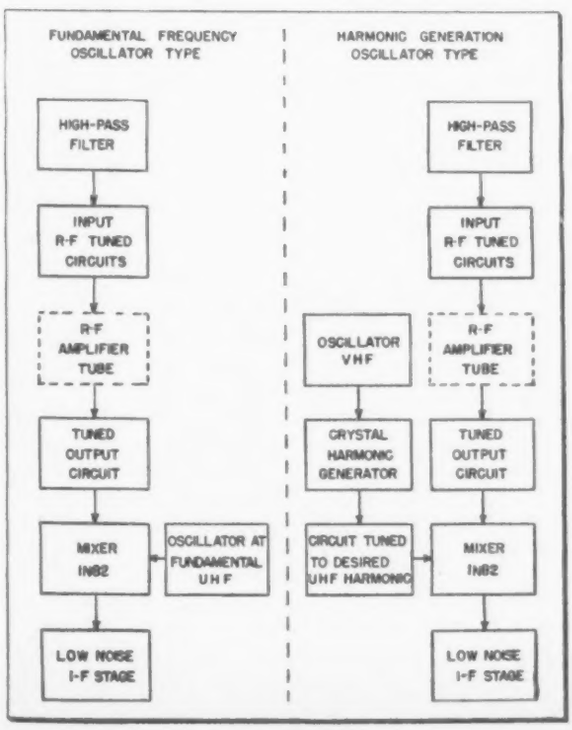
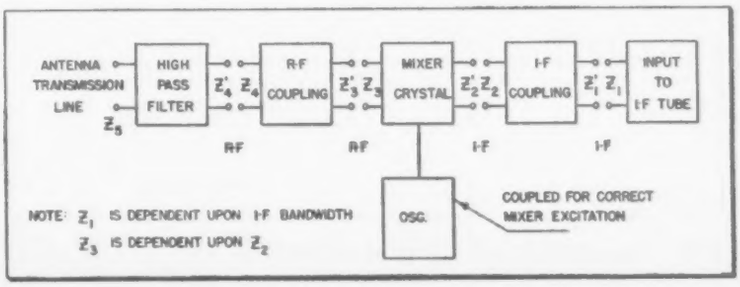


Fig. 2: (Left) two groups that summarize basic sections of UHF tuners

Fig. 3: (Below) Sequence used in designing the front end to obtain the best noise factor



UHF & VHF RECEIVERS (Continued)

less VHF channels by the same selector switching as we have on the majority of VHF receivers.

Continuous tuning has many advocates since it is possible to choose any of the 70 possible channels between 470 and 890 MC, despite the fact that there are no locations planned where even 50% of these channels will be within a useful radius. (Example: the whole state of Pennsylvania with only 48 UHF proposed station allocations, whereas there are 70 channels to be tuned.) Continuous tuning from 470 to 890 MC requires a precision mechanism and dial to enable sufficiently accurate tuning for best picture and sound. It appears to me, that the most desirable would be selection by pre-set channel positions similar to the majority of present day VHF receivers. However, when the number of channels reaches 70, it is impractical to have this many fixed positions on one switch.

It is possible to construct a tuner so that some twelve (12) positions throughout the UHF band are chosen by fixed sections of transmission line (the circuit elements) and tuned at each position by means of a small variable capacitor. Such arrangements can give complete coverage of all UHF channels, but may be quite bulky and difficult to set up for stable-tuning in combination with reliable switching of the coaxial or line elements.

Channel switching leads to a most interesting and valuable type of circuit operation. VHF tuners with coil turret assemblies have operated with a high degree of satisfaction, hence it would be logical to have similar preset coil turret units for UHF. The now well-known modification is to have a number of mechanical positions any one of which can be set up for a possible channel frequency in a given location.

(*Continued on page* 104)

TABLE II

TUBES & CRYSTAL DIODES FOR OPERATION AT UHF

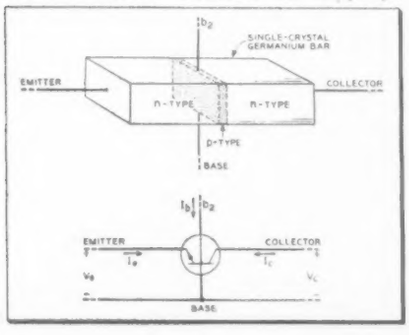
	Type	Example
R-F Amplifier	Planar Grid Triode	5768
	Modified Travelling Wave Tube	Zenith (see Robert Adler, I.R.E. March, 1951)
	Pencil Triode	5876
Mixer	Crystal Diode	1N82 Silicon Diode (Very Low Noise Factor)
	Beam Deflection Tube	A5661 (E. Herold, Electronics, May '49)
Oscillator Fundamental Frequency	Miniature Triode Acorn Triode	6T4, 6AF4, 6F4
Oscillator Harmonic Frequency Source	Crystal Diode	1N34, & 1N34A, & 1N82 with Standard V.H.F. Oscillator Tubes
Intermediate Frequency Input	Miniature Duo-Triode	6B07 & 6BK7

The New Tetrode Junction Transistor

The development of a new tetrode junction transistor by Bell Telephone Labs. heralds a significant advance in semiconductor research. As shown in Fig. 1, the primary difference between this tetrode and conventional types is the addition of a fourth electrode, b_2, to the center p-layer. Other constructional differences include a thinner p-layer, and a decreased collector junction area, reduced to about 10^{-4} sq. in.

The most important characteristic of the tetrode transistor is high-gain operation at frequencies ten times greater than is possible with conventional types. This results from the fact that the base resistance, r_b, is significantly reduced because the emitter emits electrons into the p-layer only in the small area close to the base contact. Such localization is accomplished by biasing b_2 at about −6 v. with respect to the base. Since the emitter is approximately −0.1 v. with respect to the base, electrons will not pass into the p-layer near b_2. Transistor action will be restricted to about 0.000167 in. from the base contact. For example, as $-I_{b2}$ is increased from zero to 2 ma, r_b drops from 1100 to 40 ohms. Concurrently, α goes from 0.99 to 0.75, increasing bandwidth but decreasing gain.

Fig. 1: Sketch and equivalent circuit of the new tetrode junction transistor shows connection of a fourth electrode, b_2, to p-layer



For one particular unit, the following parameters were used: $I_e = -2$ ma; $I_{b2} = -1.5$ ma; and $V_c = 24$ v. The following measured values were then observed: $r_e = 6.9$ ohms; $r_b = 92.5$ ohms; $r_c = 0.825$ megohms; $\alpha_o = 0.82$; $f_c = 18.5$ MC; and $C_c = 1.5$ μμf. When this same transistor was operated as a grounded-base amplifier, the response of Fig. 2 was recorded. Fig. 2 shows how the 3-db point is at 0.5 MC when the transistor ($R_l = 5100$ ohms) is operated as a triode with $-I_{b2} = 0$, but is extended to 5 MC when it is operated as a tetrode with $I_{b2} = -1.5$ ma. This high-frequency performance is comparable to that of a vacuum tube.

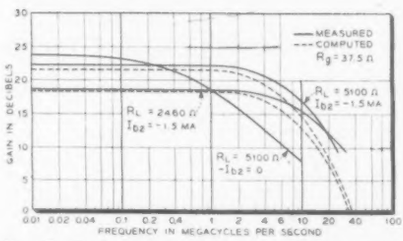


Fig. 2: Performance curves of tetrode transistor operated as a grounded-base amplifier. Note high-frequency gain when current (I_{b2}) flows

Tetrode transistors have been used satisfactorily in sine wave oscillators up to 130 MC. They perform enviably as tuned amplifiers also, producing gains of 31.8 and 11.8 db at 1 MC and 50 MC, respectively. As a wide bandpass amplifier, these new transistors boast a 15 db gain over a bandwidth of 9 MC at a center frequency of 32 MC.

For a more complete description of transistor development, the reader is referred to the article, "Transistors: A Summary of Progress in Performance," in the July 1952 issue of Tele-Tech, page 36.

Phase Shift Measurement System

Simple test arrangement for laboratory and production use provides accuracy within 0.5° on conventional oscilloscope

By EUGENE S. KATZ
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IT is difficult in the course of ordinary phase shift measurements to get a high degree of accuracy when measuring small phase shift angles. Presented here is a simple system which provides accuracy within 0.5°, when made on a conventional 5-in. oscilloscope.

Reference to Fig. 1 shows that the phase angle, θ, is equal to arc sin B/A. For very small angles, B may be only a few times the thickness of the trace. We can "buy" an n increase in sensitivity of measurement at the expense of an n increase in ambiguity. As will be shown, the ambiguity may be quickly resolved.

Instead of applying equal frequency sine waves as in Fig. 1, we place on one set of deflection plates a frequency n times that applied on the other to obtain patterns similar to those of Fig. 2. In Fig. 2, for example, $n = 4$. The distance between adjacent crossover points is equal to 360/2n degrees. So for $n = 4$, AB is 45°

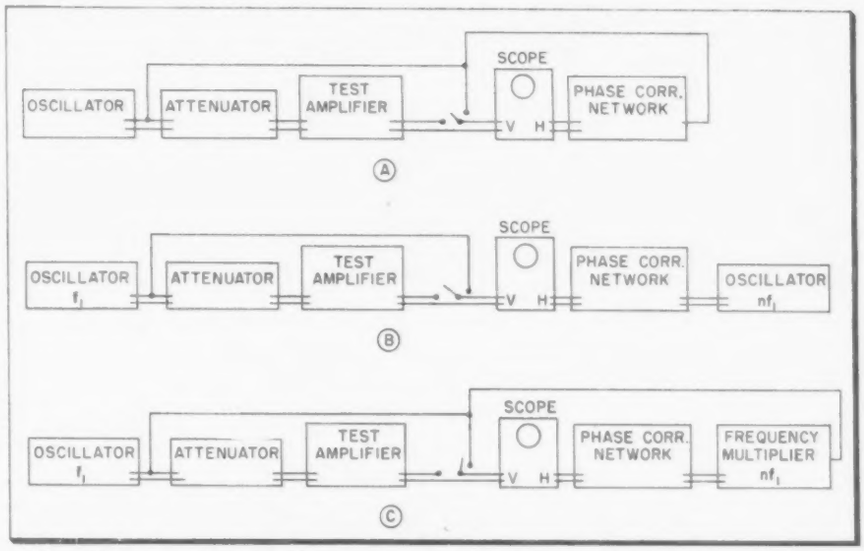


Fig. 3: Test set-ups for phase shift measurements: (A) Basic system using same frequency on vertical and horizontal plates; (B) For small angles, separate laboratory oscillator applies higher frequency to horizontal; (C) Frequency multiplier is useful for amplifier production testing

The test set-ups are shown in Fig. 3. It is convenient to use a phase correction network in the horizontal circuit. This compensates for the difference in phase shifts through the horizontal and vertical oscilloscope amplifiers. After adjusting for zero phase shift, the trace may be expanded to a size such that the adjacent crossover points, a and b, are near the opposite edges of the

(*Continued on page* 124)

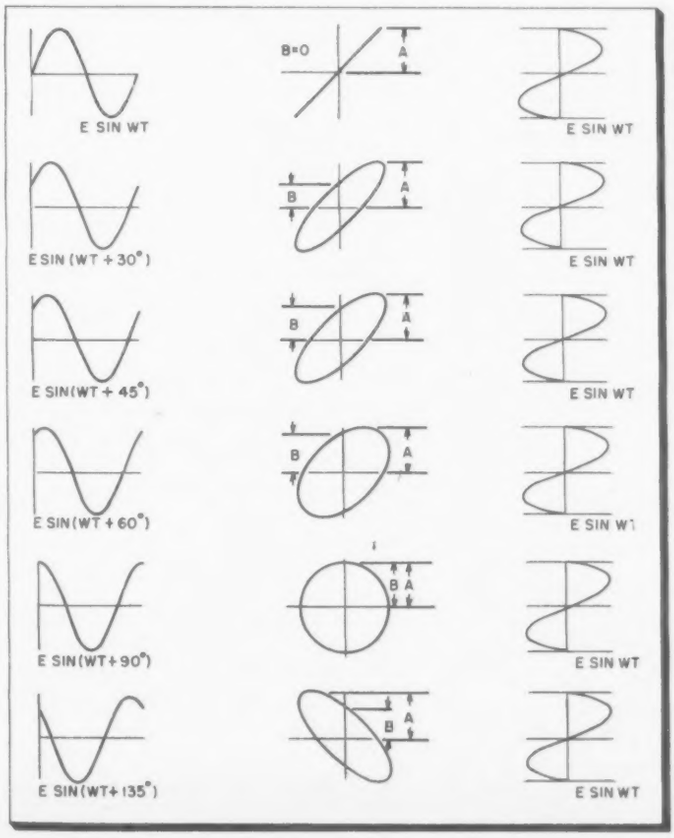
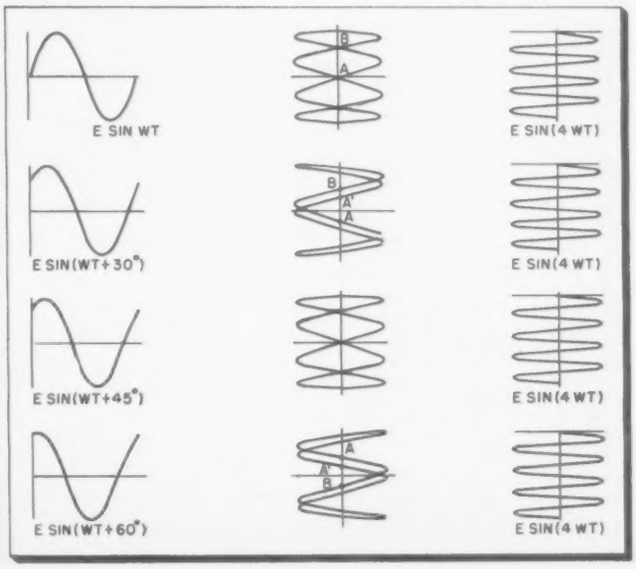


Fig. 1: (left) Phase relations of horizontal and vertical inputs produce scope patterns shown in center column. (W shown is Greek ω)

Fig. 2: With frequency applied to one set of deflection plates n times that on other set, an n increase in phase shift readability results



Global Microwave System for

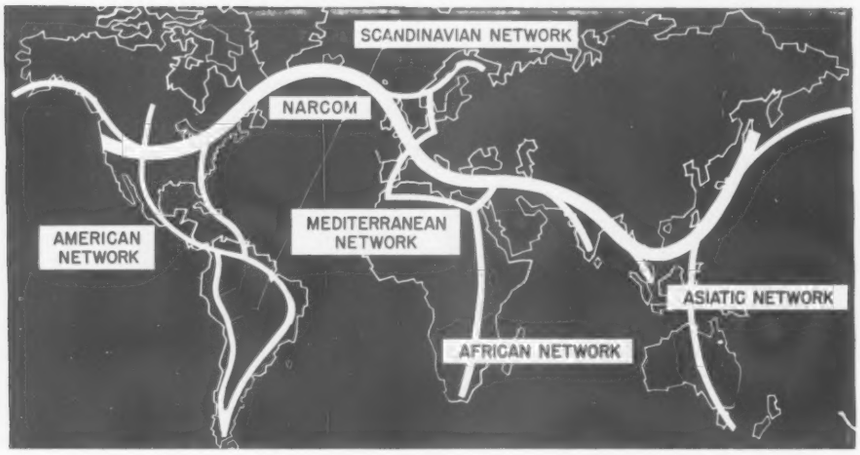


Fig. 1: Main route of UNITEL's communications system is U.S.-Greenland-Europe-Southern Asia-Japan

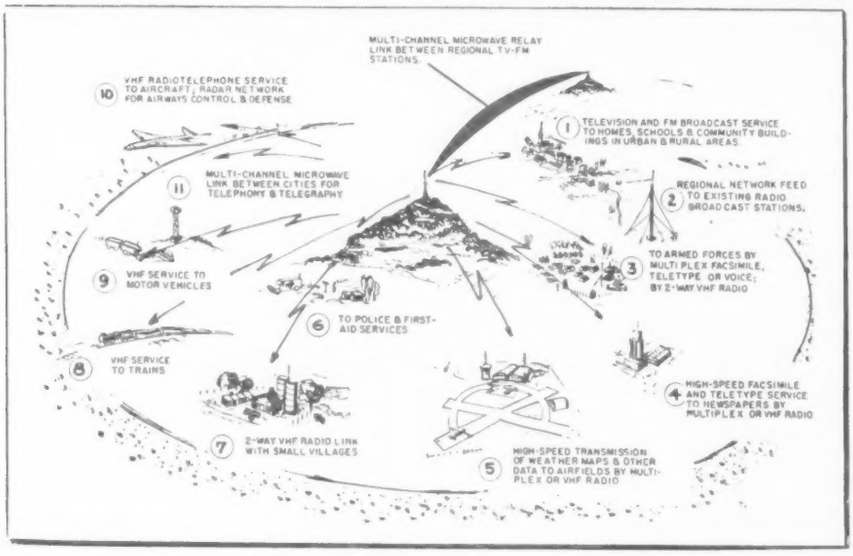

MULTI-CHANNEL MICROWAVE RELAY LINK BETWEEN REGIONAL TV-FM STATIONS.
10 VHF RADIOTELEPHONE SERVICE TO AIRCRAFT, RADAR NETWORK FOR AIRWAYS CONTROL & DEFENSE
1 TELEVISION AND FM BROADCAST SERVICE TO HOMES, SCHOOLS & COMMUNITY BUILDINGS IN URBAN & RURAL AREAS.
11 MULTI-CHANNEL MICROWAVE LINK BETWEEN CITIES FOR TELEPHONY & TELEGRAPHY
2 REGIONAL NETWORK FEED TO EXISTING RADIO BROADCAST STATIONS.
9 VHF SERVICE TO MOTOR VEHICLES
3 TO ARMED FORCES BY MULTIPLEX FACSIMILE, TELETYPE OR VOICE; BY 2-WAY VHF RADIO
6 TO POLICE & FIRST-AID SERVICES
8 VHF SERVICE TO TRAINS
4 HIGH-SPEED FACSIMILE AND TELETYPE SERVICE TO NEWSPAPERS BY MULTIPLEX OR VHF RADIO
7 2-WAY VHF RADIO LINK WITH SMALL VILLAGES
5 HIGH-SPEED TRANSMISSION OF WEATHER MAPS & OTHER DATA TO AIRFIELDS BY MULTIPLEX OR VHF RADIO

Fig. 2: Regional mountain-top station provides broadcast, communications, and relay services for area

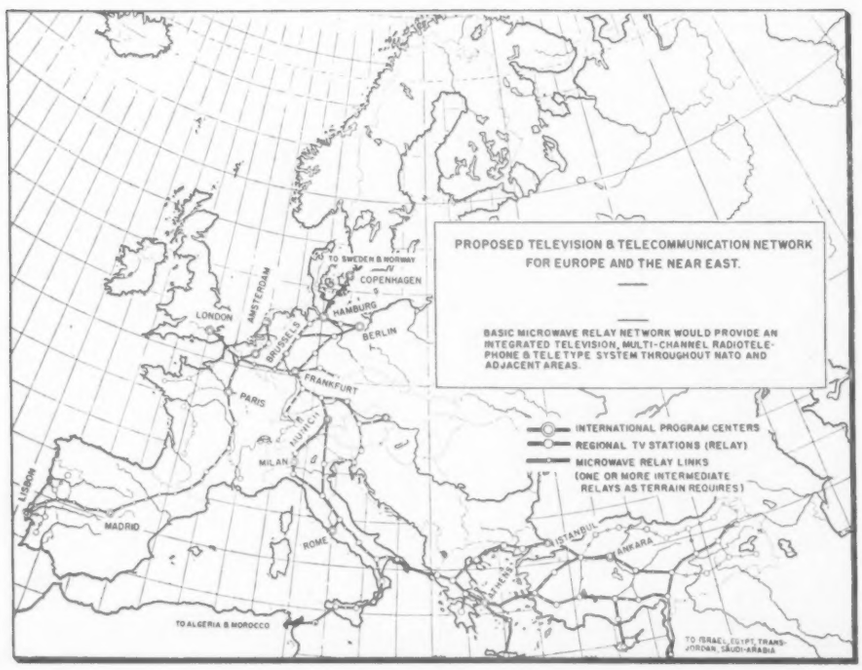


Fig. 3: Map shows how principal European cities would be linked by mountain-top microwave relay stations, then integrated with global net

Series of mountain-top stations uses latest existing techniques to circle globe. Plan favorably received by industry and government leaders here and abroad

By ALBERT J. FORMAN
Assistant Editor, TELE-TECH

A NEW and boldly imaginative system of integrated global communications is stirring the interest of engineers, educators and government leaders throughout the world. The name of the proposed system is UNITEL—Unified Telecommunications—and constitutes a novel and feasible approach to the problem of linking the peoples of the world together.

Fundamentally, UNITEL comprises a series of mountain-top multi-channel microwave and FM-type VHF radio relays linking regional broadcast and communications stations. Fig. 1 shows how the main network path will go from the U. S. to Europe via Greenland and Iceland, then through the Near East, across southern Asia, and up to Japan. The relay system is based on the little realized fact that all large land masses are linked by island chains. Exhaustive studies of maps have pointed out that the greatest single jump in this globe-girdling path, the span between Iceland and Faeroe Islands, is only 290 miles! The only uncovered distance in this plan is the string of Soviet-controlled islands north of Japan.

From the outset, it should be noted that the detailed engineering design incorporates the latest *existing* techniques, makes use of installations already constructed wherever possible, and recognizes the extreme need for maximum utilization of the frequency spectrum. Also, while the TV channel in this network has entertainment value, its primary object is informing, unifying and educating people internationally using community receivers if necessary.

Credit for the conception and for-

TV and Communications

mulation of UNITEL belongs to four men: William S. Halstead and Murray G. Crosby, system planners; Dr. Walter Duschinsky, station designer; and Henry F. Holthusen, attorney and diplomat.

Basic building block of the projected plan is the regional mountain-top station shown in Fig. 2. Its functions include TV, AM network feed FM broadcasting, radar, communications and air navigation. Of notable interest is the inclusion of a new method of low level frequency division multiplex which gives standard FM transmitters two additional program channels for one facsimile or 15 teletype units, without interfering with the regular broadcast.

The regional station will be linked with similar installations either directly or by relay stations. High altitude and air turbulence increase propagation distance, allowing microwave relay separations of over 50 miles. For longer jumps, say 125 to 150 miles, high power VHF can be the connecting medium. For 200-mile spans over water, coaxial cable, super-power VHF or intermediate weather-ship relay can do the job.

Construction and servicing may be accomplished by helicopter techniques presently being used in Korea. A station can be set up in this way in about 60 days. Besides saving the time and money that would be required for road construction if airlift were not used, a central engineering maintenance crew could be flown to trouble spots, thereby minimizing the number of technicians needed. Most of the relay stations would be unattended and all would have duplicate equipment in case of failure.

Progress to Date

Over a period of three years, an intensive examination of geographical problems throughout the world was made, followed by survey trips. The Japanese Network was designed with the idea of connecting with a world-wide system. Using the mountain top and relay system approach, construction has started on the Tokyo station (see Feb. 1952 TELE-TECH, p. 57) and in five years, 22 stations will entirely cover Japan's islands.

Fig. 3 illustrates a telecommunications network for Europe and Near East. In some cases, existing broadcast installations are utilized, being tied together to permit unified network operation which is so badly lacking. Inadequate communications systems are the reason UNITEL planners have been invited to Turkey, Japan, Egypt and Pan-American nations. Overcoming these limitations on a national basis is the immediate application of the plan. Ultimately, interconnection of these national systems will provide the global coverage.

Receiving strong interest is the North Atlantic Relay Communications System (NARCOM), which employs microwave and VHF stations from New York through Canada, across Greenland and Iceland, and on to Scotland via the Faeroe and Shetland Islands. See Figs. 4 and 5. In addition to carrying a TV chan-

(*Continued on page 118*)

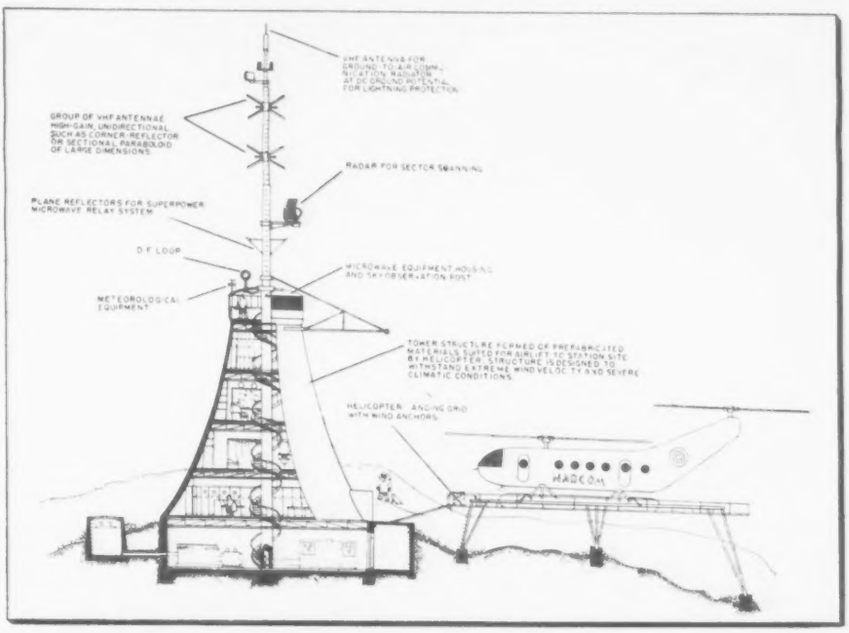
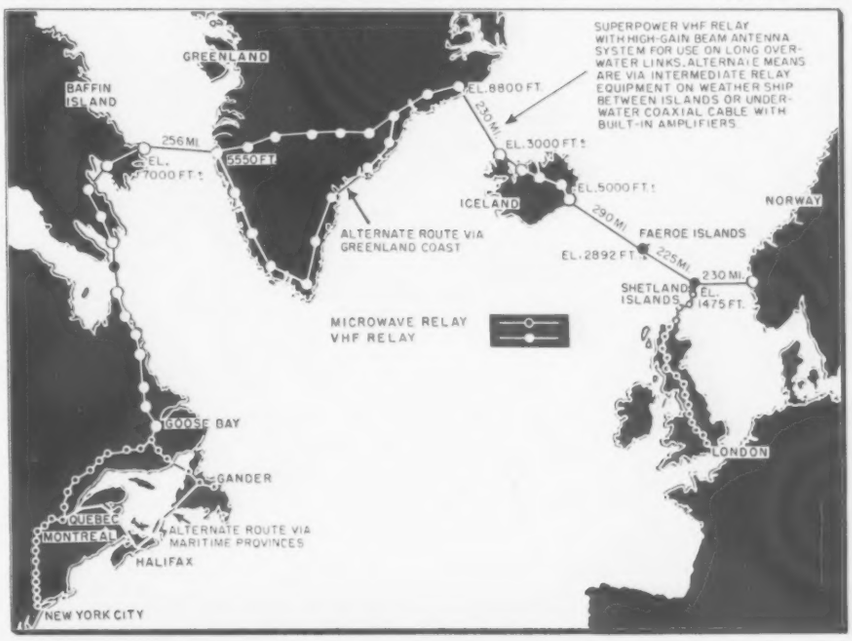

GROUP OF VHF ANTENNAE HIGH-GAIN, UNIDIRECTIONAL SUCH AS CORNER-REFLECTOR OR SECTIONAL PARABOLOID OF LARGE DIMENSIONS
RADAR FOR SECTOR SCANNING
PLANE REFLECTORS FOR SUPERPOWER MICROWAVE RELAY SYSTEM
D.F. LOOP
METEOROLOGICAL EQUIPMENT
HELICOPTER LANDING GRID WITH WIND ANCHORS
NARCOM

Fig. 4: Representative station in NARCOM system has equipment for microwave relay, VHF communications, weather telemetering, and radar scanning. Radar for air-warning service should prove effective since Path coincides with shortest eastern bombing route from the Soviet Union. Present helicopter techniques would be used for construction and maintenance. Other stations would remain unattended

Fig. 5: NARCOM route requires some 70 microwave and VHF relay stations to span Atlantic Ocean. Longest jump of 290 mi. from Iceland to Faeroe Isls. would be made by coax, ships, or super-power VHF



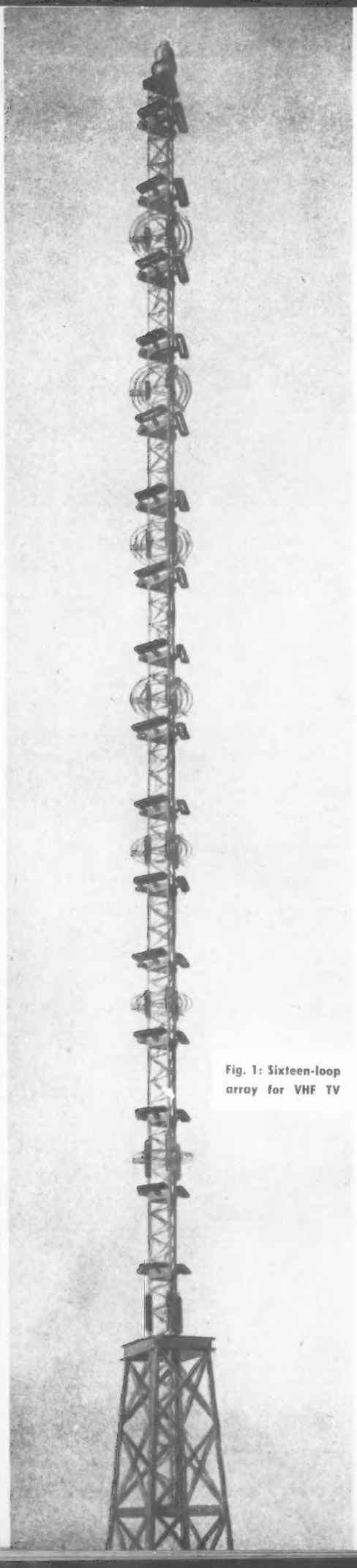


Fig. 1: Sixteen-loop array for VHF TV

High-Gain Loop

Sixteen-loop array for high-band VHF produces 316 kw ERP. Radiation pattern is omnidirectional within 0.5 db. Loop phasing improves close-in coverage

By A. G. KANDOIAN R. A. FELSENHELD W. SICHAK

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THE trend in TV broadcasting is towards higher effective radiated powers. It is generally more economical to increase the ERP by increasing the antenna gain than by increasing the transmitter power output as long as the required antenna gain is less than about 20 (for high-band TV channels 7-13). This paper discusses the extension of the previous design[1] to allow the use of as many as 16 loops. Fig. 1 shows a 16-loop array and Fig. 2 shows details of an individual loop.

The structural design of the antenna system was worked out in cooperation with the Blaw-Knox Co. The loops are mounted on a triangular steel lattice structure to whatever height necessary to achieve the desired power gain. The loop spacing is a constant 5 ft. for channels 7-13. For the eight loop array designed originally the maximum height was 40 ft. A steel lattice 14 in. on a side was sufficient for this height structure. In order to accommodate as many as 16 loops—a total height of 80 ft.—it is necessary to go to a larger lattice 17 in. on a side. Fig. 3 shows structural data for antennas with 2, 4, 8, 12 and 16 loops. It is seen that actually four sizes of tower sections are available, types D, E, F and K. Two and four loop arrays use type D sections, 8-loop array use D and E sections, 12-loop array uses D, E and F sections, while the 16-loop array uses all four type sections. The antenna meets all the RTMA specifications.

The theory and characteristics of the loop have been previously described[1] and do not require elaboration. The impedance at the center feed point is essentially 50 ohms. Since this impedance is subject to some variation because of manufacturing tolerances, slight variations in tower section etc., we introduce at this point a variable Z_0 transformer whose design is shown in Fig. 4. It is essentially a quarter-wave transformer that uses flattened elliptical center and outer conductors whose relative axes are adjustable. This enables final adjustment for a swr of less than 1.05 on each individual loop. However, this is not an adjustment that need be used in the field.

Feed System

The feed system used previously is shown in Fig. 5. The length of line to all loops is the same. Each loop is matched to a 1⅝ in., 50 ohm air line. At each junction a quarter-wave transformer is used to match to 50 ohms. Thus all interconnecting lines are matched and their lengths are determined by mechanical considerations. Electrically, this design is straightforward, and can be applied to feed a very large number of radiators. Mechanically the design becomes difficult if more than eight loops are fed because there is not enough room within the steel lattice structure for all the rigid lines and right angle bends. All the lines being rigid also represents a difficult me-

Antenna for Television Broadcasting

chanical alignment problem during the assembly of the loops on the steel structure. These difficulties may be eliminated if solid dielectric cables are used to feed the individual loops. Such a design is shown schematically in Fig. 6. From a common transformer assembly, equal lengths of RG-17/U cables go to each loop.

If all of the cables of a 16-loop array were tied in parallel at the junction point the resulting impedance would be $^{50}/_{16}$ or approximately 3 ohms which is too low to transform conveniently back to 50 ohms over the complete video spectrum. The matching problem would be greatly simplified if it were possible to connect the cables in series-parrallel combinations as is often done in lumped circuit work. Fig. 7a shows one of the ways sixteen 50 ohm loads can be connected together such that the input impedance is 50 ohms. This circuit cannot be obtained in a simple system using transmission lines, but 16 transmission lines can be connected together so that the input impedance is $^{50}/_{4}$ ohms instead of $^{50}/_{16}$ ohms as shown schematically in Fig. 7b.

This is done by using a balun, which is normally used to connect a coaxial line to a balanced antenna. In a simple balun, Fig. 8a, the two 50 ohm output lines are in series so that the input impedance is 100 ohms. If two more lines are connected to the output, Fig. 8b, the input impedance becomes 50 ohms. If N 50 ohm lines are connected to the output, the input impedance becomes 200/N. The number of output lines must be a multiple of 2. Fig. 8c is a sketch of the balun transformer. The shield is a half wavelength long, shorted at both ends, so that it presents a high impedance at the center. The inner conductors of the output lines are connected to the two sides of the gap in the input line. The lines connected to one side of the gap are all in phase, but are 180° out of phase (at all frequencies) with the lines connected to the other side of the gap. The loops connected to one side of the balun are reversed so that all loops radiate in phase. Two quarter-wave transformers are used to match to 50 ohms. Only these transformers are changed to accommodate any even number of output lines from 4 to 16 at any channel between channels 7 and 13; all other parts of the balun remain the same.

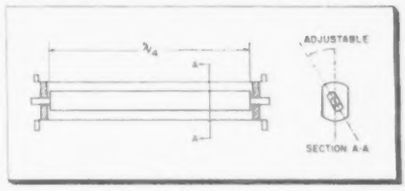


Fig. 4: Variable Z_o quarter-wave transformer

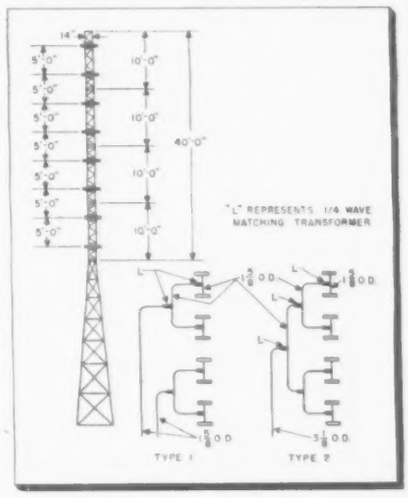


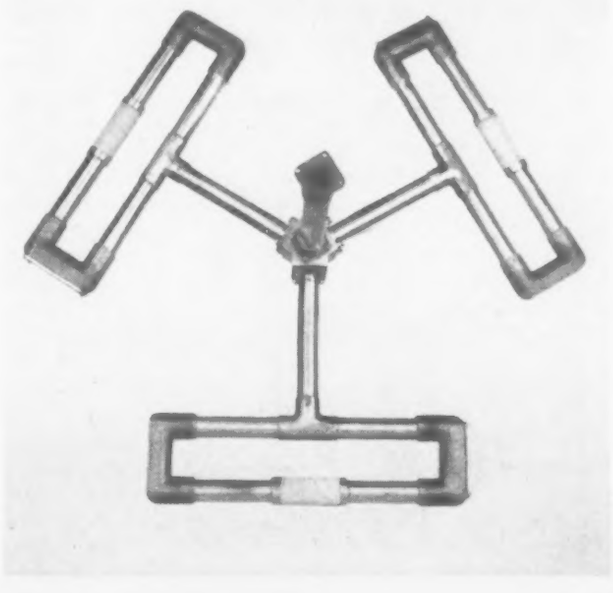
Fig. 5: Feedline arrangement used previously

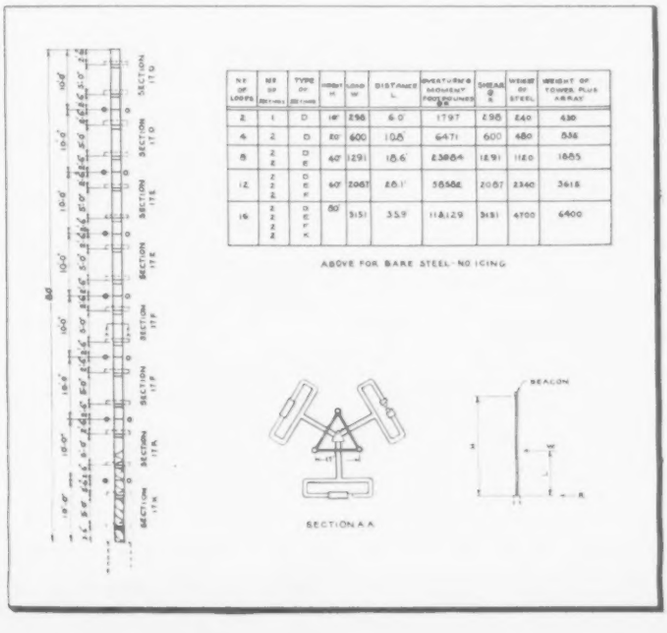
Coupling Between Loops

A problem, not fully foreseen in the original design of the stacked loop array for TV application is the effect of the very slight coupling between successive pairs of loops on the input impedance of each loop (the swr looking in each loop). Even though this coupling is low it puts a small but noticeable variation in impedance over the video bandwidth.

It turns out that it is not possible to compensate for this effect electrically in a simple manner because of the long path length between successive pairs of loops. A practical way out however is to place simple untuned isolation rings between pairs of loops. Fig. 10 shows some of the details of the isolating ring and balun located at the center of the antenna array.

Fig. 2: (l) Detail of an individual loop. Fig. 3: (r) Structural data for FTL Type 17 high-band tower shows number of sections for various arrays





LOOP ANTENNA *(Continued)*

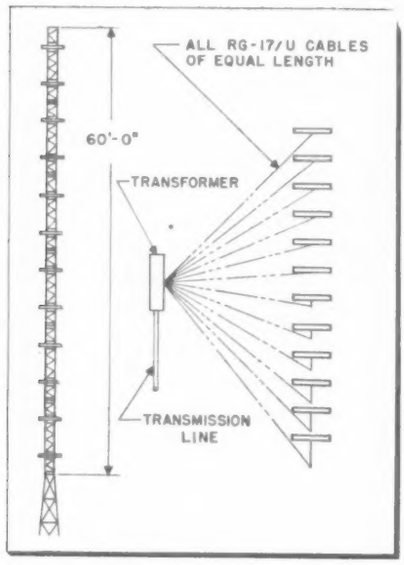


Fig. 6: Common transformer feedline system

A schematic of the diplexer is shown in Fig. 9. The two cavities are tuned to the sound carrier frequency. Cavity #1 acts as a band pass filter for the sound transmission line while cavity #2 acts as band reject filter for the sound signals in the picture line. A small amount of the sound transmitter power (less than 0.3 db) is absorbed in each cavity. Because of their high selectivity these cavities have a negligible effect on the picture transmission from the transmitter to the antenna.

An additional quarter-wave tuned circuit is coupled at the input end of the visual line in order to load it at the sound frequency. This is required to suppress possible oscillation of the output stage of the picture transmitter at that frequency due to the highly reactive load that the diplexer would otherwise present.

The cavities are formed of 6⅛ in. coaxial transmission line. Connecting sections are of 1⅝ in. coaxial line. Lengths of the line elements are cut to quarter wavelength for the aural carrier of the band for which the diplexer is to be used. Fine adjustment of the tuning of each cavity is provided by a capacitance plate and screw with locking nut on the side of the cavity. This has been found to be more satisfactory than vernier adjustment of the length of the inner conductor.

Typical performance data, measured on a diplexer tuned to channel 7, are as follows:

SWR at picture carrier less than 1.05
SWR at sound carrier less than 1.20
Insertion loss—picture carrier to antenna line negligible
Insertion loss—sound carrier to antenna line less than 0.5 db
Rejection of sound carrier into picture line more than 26 db
Rejection of picture carrier into sound line more than 23 db

The above data were taken with matched loads. A photograph of the unit is shown in Fig. 11.

A blower is used to supply cooling air to the cavities. The cavity inner conductors are made of silver plated invar to minimize the shift in resonant frequency due to heating, but a small amount of air (40 cu. ft. per minute per cavity) is used so that the cavities, tuned with a signal generator, need not be retuned when full transmitter power is applied.

The complete antenna system consists of the diplexer, transmission line, and the antenna proper. The diplexer is installed near the transmitter and connected to the antenna through 50 ohm coaxial air line. The size of the transmission line depends on the average power level and how much loss can be tolerated. Generally 3⅛ in. or 6⅛ in. diameter line is used. Only one coaxial line is required with this antenna.

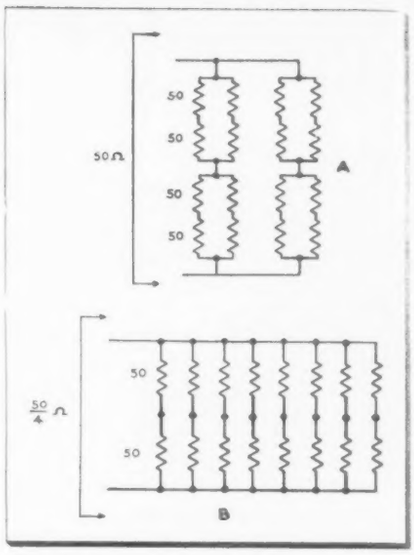


Fig. 7: Series-parallel combinations of sixteen 50-ohm loads shows (a) ideal and (b) practical

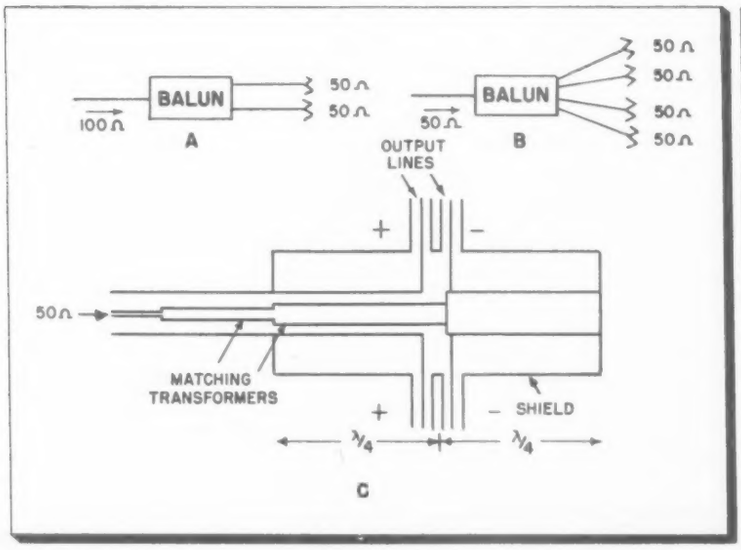
TABLE I

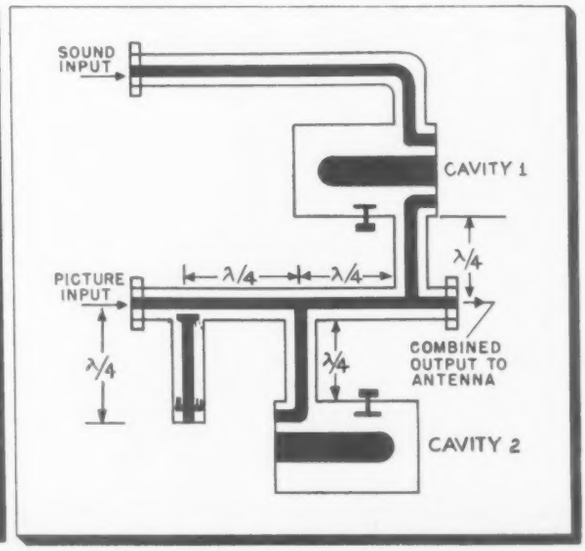
Number of Loops	Gain
2	2.0
4	4.0
8	8.4
12	13
16	17

The gain over a half-wave dipole of the FTL-23A is given in Table I for channels 7 to 13.

(Continued on page 126)

Fig. 8: (l) Construction and impedances of a balun transformer for connecting the coax line to the antenna. Fig. 9: (r) Two-cavity TV diplexer





Subminiaturization of Servo Amplifiers

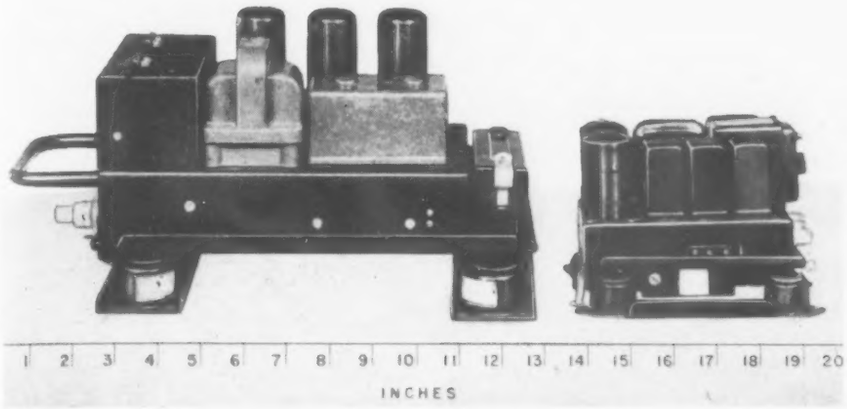


Fig. 1: Using unitized construction and resin embedment, size of power unit is reduced 70%

Unitized construction, cast resin component embedment reduce power unit volume 70%. Pressurized connectors, parts placement permit operation at high temperature and altitude

By ALBERT C. SMITH
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THE approach to the design of a servo-amplifier is somewhat different from the design of a communications type amplifier. The servo-amplifier has something more to do than to amplify. It must perform physical work. Servo-amplifiers operate on comparatively low frequencies, usually 400 cycles. Depending upon whether the amplifier drives the servo motor through a relay or by impedance match between the output tube and the motor, different problems are encountered. Relay type output, required for some systems, can result in a more universal amplifier, but brings up the problem of radio noise interference and the use of usually bulky filters. Impedance matching directly between the output tube and motor largely eliminates the radio noise problem, but brings up the problem of finding a suitable miniature or subminiature tube capable of handling the power required and having an impedance that can be matched with optimum windings.

Great strides have been made in size and weight reduction of this type of equipment. These have been largely through the use of unitized construction and/or cast resin embedment. Fig. 1 shows the size reduction realized in the power unit for a capacitance type liquid measuring system. The reduction in overall volume of the unit is approximately 70%, and weight reduction is over 50%.

With the newer specifications becoming more and more challenging with regard to conditions of high altitude pressure, temperature extremes, presence of water, and vibration, hermetic sealing of certain critical parts is required.

Unitized Construction

Fig. 2 shows the unitized construction of three of the critical components of the small power unit previously mentioned. The power unit is designed to meet a specification which requires functional tests to be made over the range of temperatures from −65° F. to +160° F. For continued operational use, however, the maximum recommended ambient temperature is 125° F.

One amplifier, being designed for applications which require performance at an ambient temperature of 200° F., is a universal control amplifier. This unit is expected to pass tests combining high and low temperature with high and low altitude pressures. Because of the high ambient temperature and the desire to mount a subminiature triode, rectifier, and pentode in one envelope, the construction shown in Fig. 3 was used. This unit places the three tubes in a minimum amount of space and in metal clamps which readily conduct the heat to the case and chassis for lower bulb temperatures. The unit shown has solder type terminals; however, it may be produced with plug-in terminals for commercial use.

Hermetic Sealing

The problems of electrical spacing for high altitude conditions are presently met by both the hermetically sealed components and those which are cast in resin. The cast resin types, however, offer excellent integral support to circuit components.

Most of our control and measurement systems utilize the selfbalancing null type bridge circuit and use the ac bridge or dc bridge input. One component often used in servo-amplifiers and one which has proven difficult to miniaturize is the 400 cycle synchronous vibrator, which depends partly upon physical dimensions for resonant frequencies.

One representative circuit uses a typical dc bridge input wherein a vibrator is used to chop the output of the dc bridge to provide the proper input for an ac amplifier, in order to amplify the signal and use it on a servo motor in the output. The dc bridge circuit is used where extremely low values of input signal are encountered. Because of the extremely high responsibility placed upon the control circuits wherein the vibrators are used, the miniature synchronous vibrator is being designed for a minimum life of 1000 hours. Fig. 4 shows the internal structure of the miniature 400 cycle vibrator.

Component Locations

From the standpoint of minimizing the effect of heat-producing parts, much attention should be given to the relative placement of those parts with respect to other critical circuit components. Power transformers, tubes, and power supplies should be located as far as possible from bridge R-C networks, reference capacitors, etc. Fig. 5 shows one unit which follows this practice. Note that the tubes and transformer are on the back of the chassis, while the reference capacitors are located near the front.

Since the servo amplifier unit

SERVO AMPLIFIERS (Continued)

usually contains any necessary calibration adjustments for the servo system, potentiometers become a large influencing factor in the layout of a new unit. Current systems require, in one design, two potentiometers and, in another, 14. One design which previously required the use of two adjusting potentiometers and a range switch, has been re-designed to make use of two ten-turn helical potentiometers. In these units, the potentiometer wipers require 10 complete turns of the adjusting screw to travel from stop to stop. This increased travel range permits a higher degree of resolution for any given rotation of the adjusting screws, to facilitate easier settings. On some units, use of tandem potentiometers with concentric shafts is contemplated.

External connections to the servo amplifier unit can consist of both low and high impedance lines. For the high impedance lines a series of small pressurized connectors has been developed. These connectors are similar to, but not interchangeable with, AN type BNC r-f connectors. They feature more positive cable clamping provisions, have longer creepage distances between conductor and shell, and are liquid and pressure tight. Fig. 6 shows one application of these connectors. In this case, the mating receptacles on the amplifier have been scaled down considerably in size and weight. Compatibility with other standard size mating connectors has been retained. For some other connections to other amplifiers, standard AN type connectors are used where suitable. Special harness connectors have been used in some instances where the size and shape can become an integral part of the design.

Power Supplies

In the servo-amplifier, a certain amount of distortion and nonlinearity can usually be tolerated. This fact allows us to run the tubes at lower than normal plate voltages. As a result, we now use capacitors rated at 200 dc, where previously 450 v. and 600 v. capacitors were required. This results in appreciable size reduction in power supplies.

The use of autotransformers wherever possible results in a material saving in size and weight. Fig. 7 shows typical servo-amplifier output circuits using (a) the conventional transformer and (b) the autotransformer. In circuit (a), the servo-motor amplifier phase winding and resonating capacitor are connected in the center tap of the discriminator plate transformer winding. In circuit (b), the servo-motor amplifier phase winding and resonating capacitor are connected in the cathode circuit of the discriminator tube. This type of connection results in a gain of less than one for the discriminator stage. In order to use this type of circuit, it was necessary to design a two-stage voltage amplifier, with a gain of from 12 to 1500, and to use a coupling transformer to provide adequate grid voltages for the discriminator. With proper selection of tubes, etc., the particular system for comparable performance now requires 18 watts power as against 25 watts for the previous design and uses the smaller transformer. Careful selection of tubes as regards filament drain will, of course, also tend to reduce the size and weight of required transformers. Further reductions may be obtained by the use of higher operating temperatures.

Use of Class A insulating materials with accompanying derating of the life of the transformer would be one possible solution. Class A insulating materials consist of the currently used paper, tapes, varnish, etc. Of particular interest for larger type transformers, that is where considerable power is used, the use of Class H insulating materials is desirable. These are glass laminates, silicone tapes, Teflon, etc.

Dissipating Heat

With the allowance of higher heat dissipation, the heat must be disposed of in the best possible manner. One particularly advantageous way is the use of higher heat-conductive filling materials such as magnesium oxide, and casting resins with various fillers.

We have used selenium rectifiers primarily where current drain is low and in operating ambient tempera-

Fig. 2: Components of the miniaturized power unit of Fig. 1 shows unitized construction

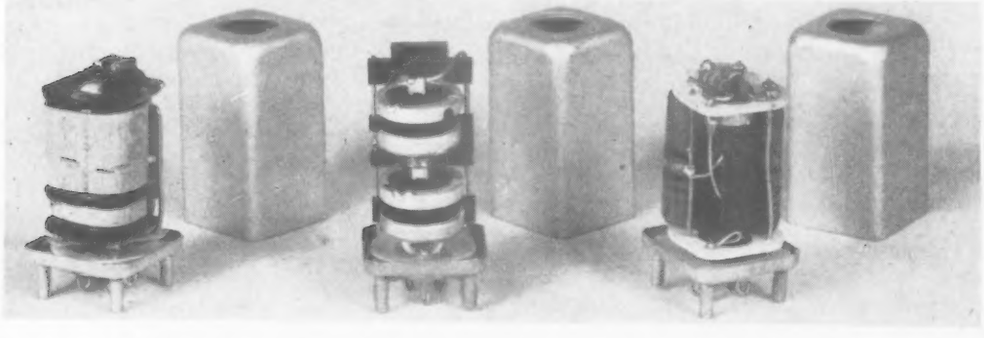


Fig. 3: Tube assembly for amplifier contains subminiature triode, rectifier and pentode

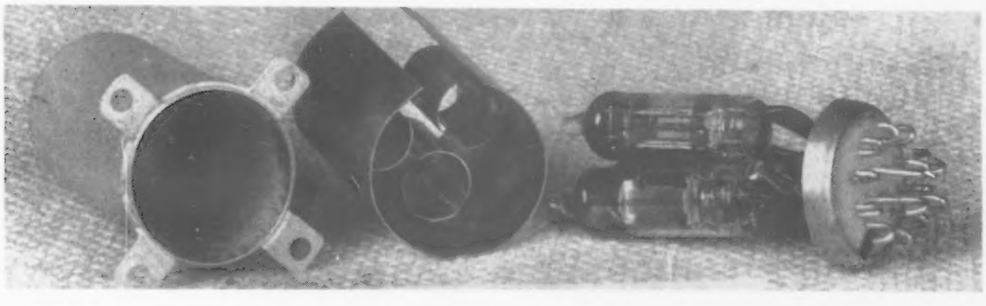
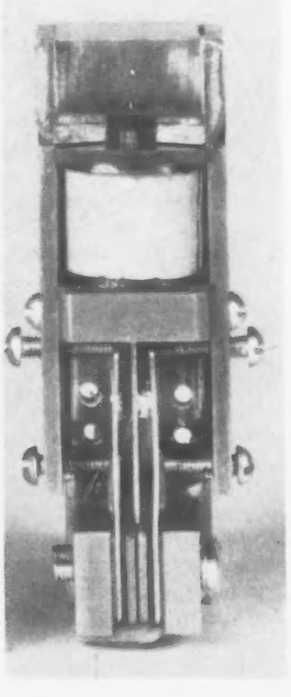


Fig. 4: Miniature 400-cycle vibrator



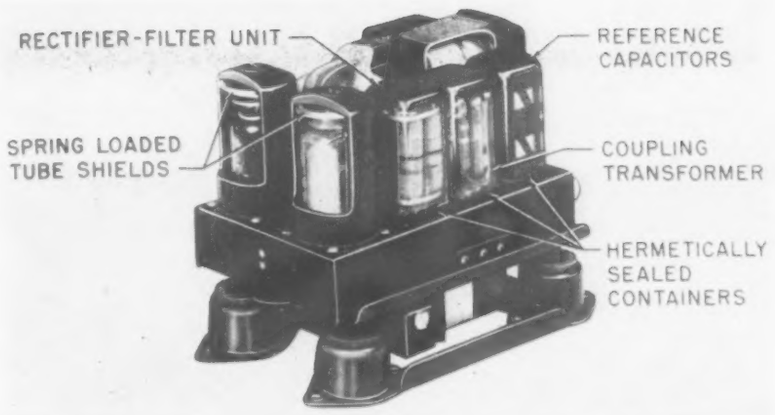


Fig. 5: Proper placement minimizes effect of heat-producing components. Note that tubes and power transformer are at left and rear, reference capacitors at right front

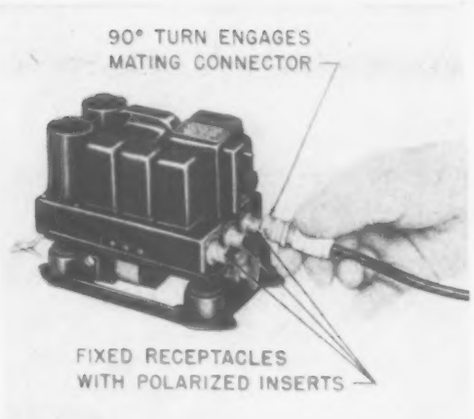


Fig. 6: External connections to servo amplifier are made with scaled-down, pressurized connectors

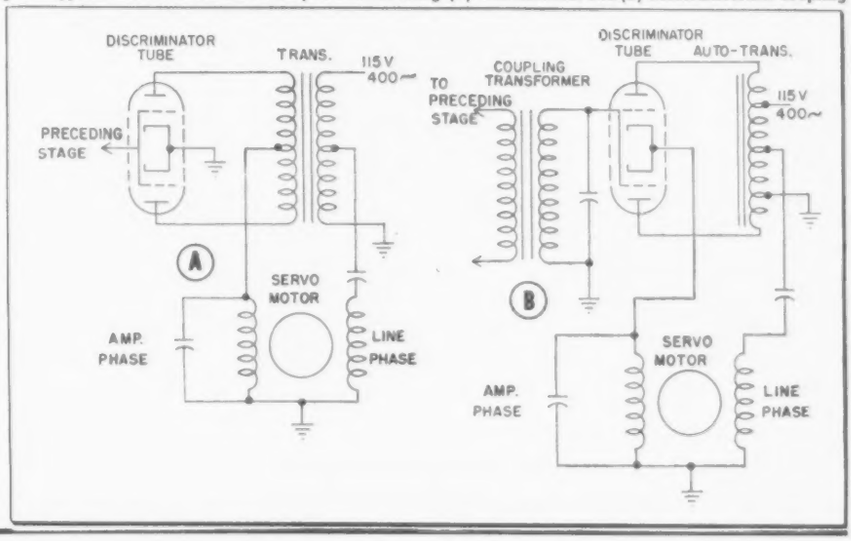
ture up to 160° F. In power supplies where heavier currents are required or higher ambient temperatures are specified, the tube type rectifiers are being used.

Vacuum Tubes

Subminiature tubes have been the major factor in providing the impetus towards miniature design and construction. We are using subminiature tubes in all new designs with the exception of output tubes, where the miniature twin triode type is still used. Recent developments have provided subminiature triodes of sufficient power output such that two subminiatures may be used to replace the miniature. With the need

(*Continued on page* 122)

Fig. 7: Typical discriminator servo output circuits using (a) conventional and (b) autotransformer coupling



An Inexpensive TV Prompter

LOW-cost spot announcements have strong appeal to small advertisers, particularly if a method can be used which is less expensive than film or slides. Since the cameras are on all day and operators are also on duty, live studio commercials appear to be the answer. Not only are they cheaper, but they have the added appeal of personal sales. The only obstacle is the announcer's difficulty in memorizing five or six different commercials in a day.

The inexpensive solution is the simple TV prompter described by Leonard W. German, engineer at WHIO-TV, Dayton, Ohio, which costs only a few dollars to build. With the aid of this prompter, shown in Fig. 1, the number of live spots in front of the WHIO-TV camera has increased tremendously in the last six to ten months, but the size of the announcing staff has not been increased.

The idea of mounting this instrument on the camera pedestal right below the lenses is to keep the announcer's eyes trained directly toward the camera. See Fig. 2. By operating the camera at the proper distance from the announcer (12 to 14 ft. for 90 and 135 mm lenses) it is difficult to detect that he is looking below the lenses rather than into it. The width was determined so his eyes would not be seen roaming back and forth.

(*Continued on page* 132)

Fig. 1: Prompter consists of base board, frame, and two rollers rotated by handles. Mounting bracket on back of center base board is box which fits into larger box fixed on pedestal

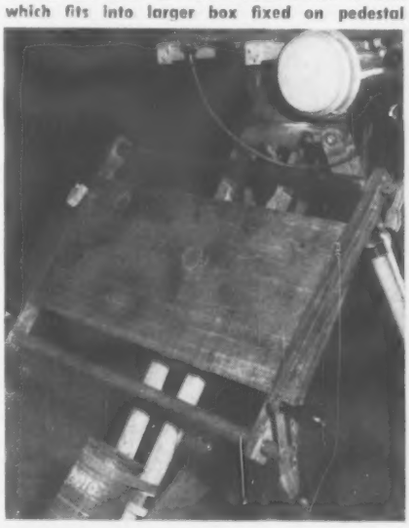


Fig. 2: In operation, prompter is mounted just below camera and moved by turning upper handle. Pointer at upper left indicates line being read on the 24-inch wide roll of white paper

Recording Binaural

Use of LP discs having two recorded bands offers a very compatible and practical binaural record system. Great new market potential indicated for record player manufacturers.

Author viewing binaural cut in process on special recording lathe

By EMORY COOK
Cook Laboratories
Stamford, Conn.

IF the advantages and potential wide sales appeal of binaural sound are to be exercised, the realm of disc-recording, where cost and compatibility factors with existing standards are favorable, offers great possibilities. Let us then review the several ways in which a synchronized double track in disc can be produced:

1. A binaural recording can be made on opposite sides of a disc, playing back both sides simultaneously. This method is not very practical however, because stampers cannot possibly be centered and aligned in the press in the necessary rotational accuracy, and a wholesale redesign of playback turntables would be necessary.

2. Interleaved grooves are another theoretically possible means of binaural disc recording. This method however is costly to record and to playback and further, a great deal of special equipment would be necessitated.

3. A single sideband carrier system has been proposed, but the limitations of this method are such that the frequency range of each "ear" is restricted to a low value that could not be considered acceptable from a fidelity standpoint.

4. To date then, it appears that by far the most compatible and practical system is that of placing two recorded bands on the same side of an LP disc as diagrammed in Fig. 5.

As with ordinary recording equipment, the cutting styli move on a radius,—from outside in. Therefore existing recording equipment is easily modified to perform the mastering function. The playback arms may be integrated into a single arm containing two cartridges side by side as shown in Fig. 1.

Compatibility

The confusion of multiple standards has already shaken up the record industry once or twice and another upheaval would probably be impossible. Therefore, both the binaural record and its playback means must be interchangeable with existing standards. Due to the halving of available elapsed time with two channels, the 12-in LP is a natural starting point. With a normal 12 minutes of binaural playing time and a possible maximum of 14-15 minutes, most musical requirements can be met. The method described here produces a record which can be played (one "ear" at a time) on existing equipment, and the binaural reproducing system will likewise play regular records by simply blocking one of the cartridges up off the record.

Accurate Radial Relation

In Fig. 5 is shown the schematic arrangement for playing back the record of Fig. 4. Within the limits of travel in arc of the arm across the narrow band of grooves a high degree of accuracy of radial relation of playback points is obtained. In the practical case the positive error is made to equal to the negative error in terms of wavelengths, —at 1000 cps for instance. The maximum error then measures to be of the order of magnitude of 0.01-in. along the groove longitudinally at the middle of the record corresponding to less than a wavelength at 1000 cps along the groove. The purist might say here that we cannot tolerate a phase error of 180° in the range of maximum directional sensitivity of the human ear, but this is not true, and it is not a matter of "toleration" anyway unless we confine our remarks to the use of earphones as a listening medium. As a matter of fact, earphones can be given no consideration at all commercially. If we think in terms of spaced loudspeakers in a room then a full wavelength error at 1000 cycles can be thought of as corresponding to a motion forward or backward of one of the loudspeakers of about one foot, or a corresponding random motion of the listener in the room (such as turning the head) while the music is playing which is easily possible, in fact probable, without getting up from the chair.

Sound on Discs

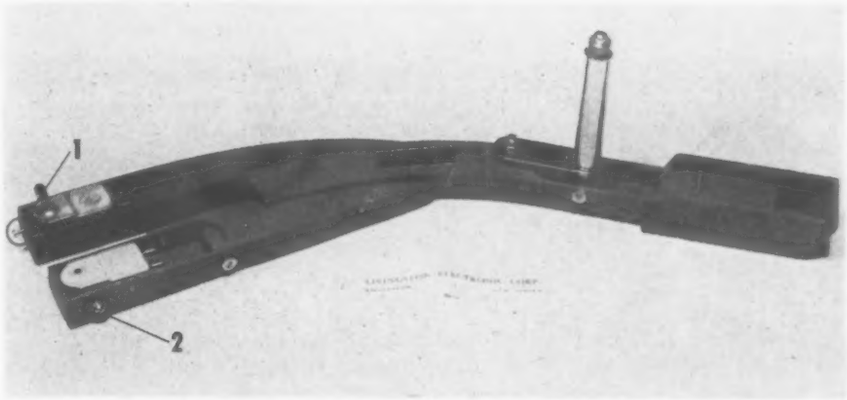


Fig. 1: Close-up of dual cartridge playback arm as manufactured by Livingston Electronic Corp., Livingston, N. Y. (1) and (2) are adjustment screws

A typical modified arm would display a dimension of 10½-in. from pivot to farthest stylus, an offset angle of 27.5° and the standard spacing of $1^{11}/_{16}$-in. The fractional spacing is chosen rather than decimals to facilitate the rough adjustment by using a standard inch rule, where the points will fall into the indentations at the specified dimension.

The radial error is not much affected by the length of the arm, and short 12 in. turntable arms are candidates for conversion.

In order to permit equal tracking pressure of each point of contact, at least one and preferably both of the cartridges must be individually pivoted for the vertical plane, although of course, if one is tempted to put up with the inconvenience, two separate arms may be operated.

Random Production Errors

No record is produced which is actually on center. The magnitude of the combined error in good commercial practice can hardly be reduced under .010-.015-in. The staggered method of interleaved grooves can not operate satisfactorily because of the centering problem alone, since there is a large angle subtended between the two points of pickup. However, the radial method is the least susceptible, in fact practically immune to centering errors such as normally encountered. But there is another and more insidious danger to watch against. In establishing a $1^{11}/_{16}$-in. dimension between points of pickup we must allow a tolerance.

Not only is it quite unthinkable to be able to align recording heads and styli on a lathe to .001-in. tolerance for each and every master, but the metal parts, especially stampers used to mold pressings are basically 0.032-in. copper as regards mechanical strength. In the modern fast cycle press and in handling they become stretched, so that $1^{11}/_{16}$-in. may become distorted around the circle. Furthermore, non-uniform cooling of pressings just removed will produce a small eccentric shrinkage on one side of the record and not the other. All these errors are of course capable of being cumulative to the effect of at least 0.015-in., and therefore we must have a mutual "lost motion" in the $1^{11}/_{16}$-in. spacing figure of ±.015-in. or thereabouts. However, since the record is started with pickups dropped in the spiralling lead-in groove, this does not mean that we shall have trouble getting into the correct grooves; it merely means instead that there is to be a "free" lateral motion of one cartridge with respect to the other. However, the business of "loose pivots," i.e., rattles, in vertically pivoted arms is well known to produce non-linear effects at some mid-frequency. The answer to the probblem is the packing of the pivot points with viscous damping, so that the compliance of the cartridge needle is two or three times higher than the viscous compliance for frequencies at and below the undamped lateral resonance.

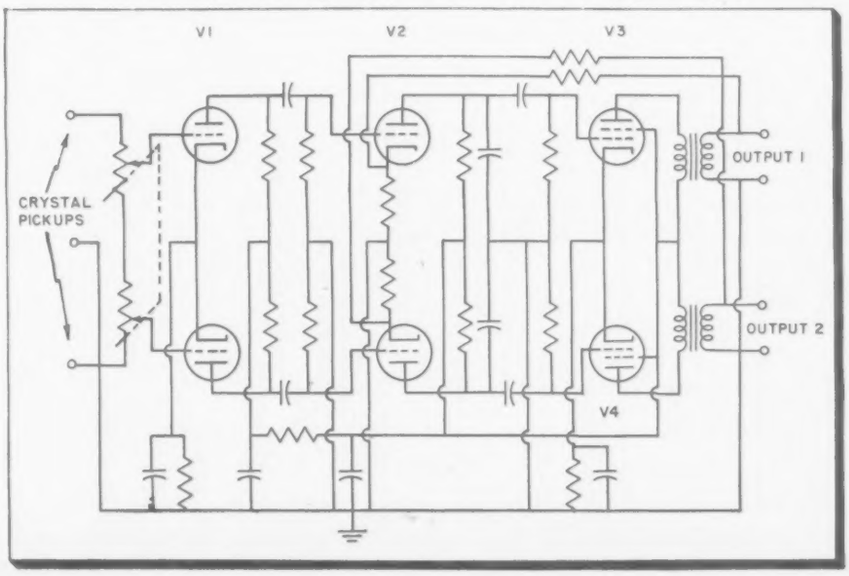
In bringing binaural into focus as a practical medium, the cost factor is particularly important. A first reaction might be that the cost would be almost doubled but this is not the case. Binaurally, power output per channel can be *less than half* that of an equivalent monaural channel for the same apparent loudness.

Using Twin Triodes

With the use of twin triodes the basic amplifier design may be doubled up (as in push-pull) without much additional cost. Since we certainly need no more than half the output power "per ear" the power supply is the same. The twin cathode, screens and plate supplies may be by-passed through common capacitors, since a moderate amount of crosstalk between channels is permissible. The only serious added cost will be that of the second output transformer, and means for reducing even that appear to be forthcoming.

In the "minimum" design of Fig. 2, there are only 16 one or half-watt resistors, 4 audio condensers and 4

Fig. 2: Minimum binaural amplifier design involves only 16 one- or half-watt resistors, 4 audio capacitors, and 4 tubes not including power supply



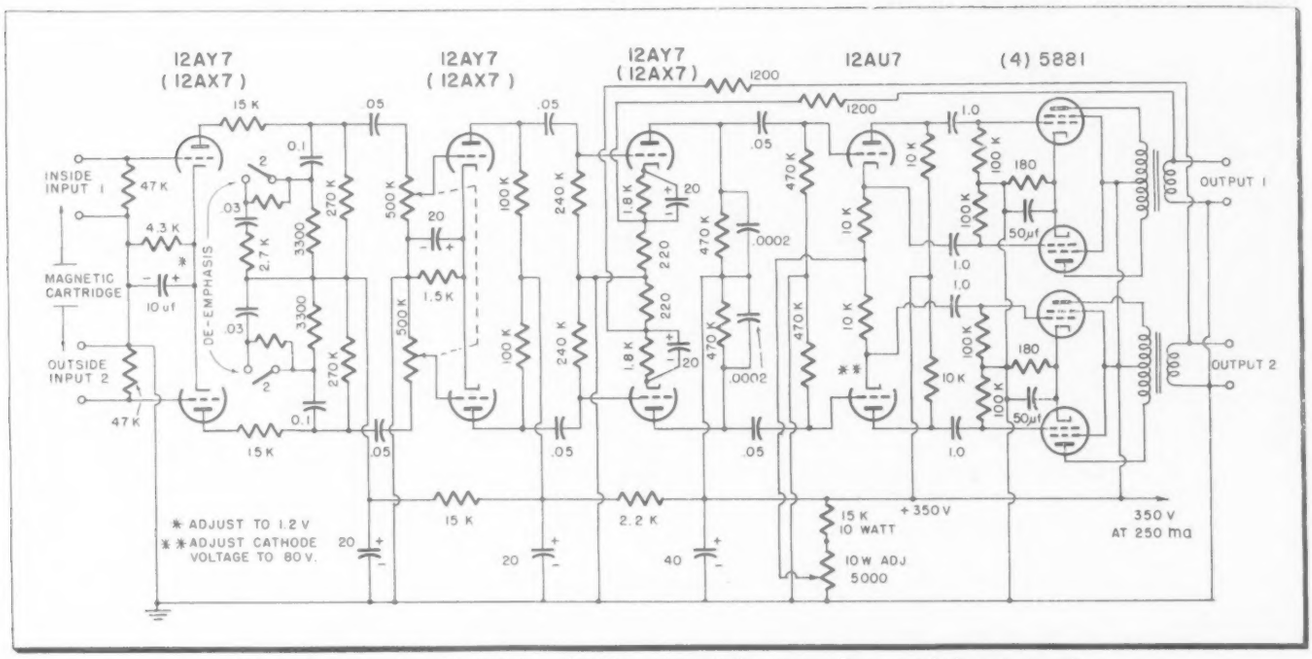


Fig. 3: Complete schematic of high quality binaural amplifying system. Power supply is separate unit

tubes, not including the power supply. No more decoupling or filtering is necessary than with a regular amplifier. The A-B comparison between binaural and monaural on such a minimum system with corresponding small speakers is perfectly astounding, probably because the cheaper monaural systems are so unsatisfactory in themselves. Yet it is hard to see where such an amplifier could cost more than a few dollars extra.

The opposite extreme would be something along the line of Fig. 3, where provision for magnetic cartridges is made, together with phase-splitting so that each output is balanced. Again the increased cost over that of a straight "push-pull" design is very nominal, if one is to compare it with a regular amplifier using four output tubes as a cost reference.

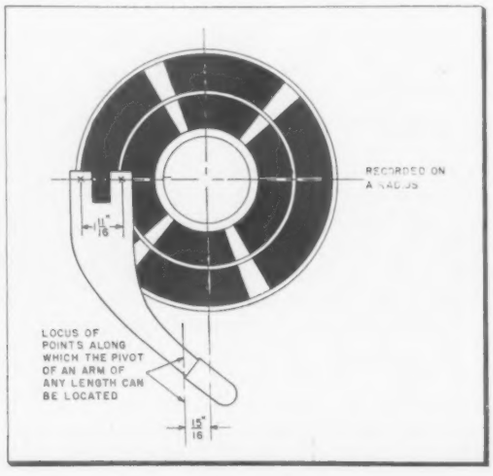
For equalizing the effective high frequency response of the channels in the room a condenser may be introduced across one or the other of the 220 ohm feedback re-introduction points in the 3rd stage of Fig. 3.

Test & Alignment

In addition to the necessity for an adjustment to permit re-setting the $1^{11}/_{16}$-in. dimension should cartridges be changed, there must also be a "fore and aft" adjustment provided so that there is no time delay error between channels,—so that they operate on the same radius. A means for locating to the required accuracy of 0.01-in. this longitudinal adjustment can be supplied through use of a test record signal. The Cook Series 30 test record is intended as a temporary standard, and in order to be palatable to non-technical users employs a slowly ticking clock as the source. The clock is fed into both channels in parallel simultaneously, in order to provide a synthetic binaural signal. When played on a binaural arm into a binaural reproducing system which has been adjusted for equal gain per "ear," the cartridges in the arm may be adjusted until the clock sound in the room appears to be neither to the right nor to the left, but dead-center. In order to prevent insofar as possible inadvertent errors, the record

(*Continued on page* 136)

Fig. 4: (Left) Photo of binaural tone arm playing back binaural disc. Fig. 5: (Right) Diagram showing how binaural arm is pivoted



Centralize Military Buying?

Nine-Point Plan to Cure Military Procurement Ills Proposed by Murray Fiebert, Mgr., Govt. Contract Div., CBS-Columbia, Inc.

THERE is increasing evidence that military procurement will become centralized, particularly in the buying of standard products, and eventually in procurement of all military items.

The tip-off is HR 8130 introduced into the House of Representatives in the Spring of 1952 and now in the Armed Services Committee. This bill would eliminate the Munitions Board and provide for a central supply agency for non-military items.

But more than this, Public Law 488, Section 638 requires the Secretary of Defense to issue regulations that will effect consolidated buying of certain items by the military.

Whether or not the end result—consolidated purchasing of military equipment through a centralized agency—is to the advantage or disadvantage of national defense and national economy is the 64-dollar question.

Arguments in Favor

Academic arguments are beginning to appear pro and con. TELE-TECH has been receiving correspondence on this subject and presents a particularly strong argument in favor of centralization of procurement functions. This argument is advanced by Murray Fiebert, Manager, Government Contract Division. CBS-Columbia, Inc., Brooklyn, New York, who gives nine reasons why centralization of procurement is desirable. These nine reasons are given in complete detail in the columns on the right.

Mr. Fiebert points out that, at present, the Army purchases through each of its seven Technical Services. The Air Force has its organizational setup with procurement offices in Dayton and several research and development installations scattered throughout the country.

The Navy procures through its different bureaus in Washington and several other locations. This, says Mr. Fiebert, is a "maze of procurement organizations, enough to thoroughly confuse the average contractor." He offers the solution contained in the accompanying nine-point plan.

Procurement Unification Plan

1 It is recommended that all procurement activities be transferred from the jurisdiction of the Chiefs of Technical Service and place directly under the jurisdiction of the Secretary of Defense. The Secretary of Defense, or an assistant, should be designated as the civilian in charge of the entire military procurement program. His authority would supersede that of the established military hierarchy.

2 Responsibility for implementing this procurement program would be placed in the hands of competent civil service employees trained for their assignments. This would obviate the necessity of using the services of military officers who are assigned on a temporary basis and transferred periodically. It would further release military personnel for purely military assignments.

3 Regulations and procedures emanating through the Secretary of Defense would be disseminated to all procurement officials and would be uniformly interpreted. Under present procedures, there are many instances where each Technical Service or Department develops a separate interpretation of a regulation.

4 It would make possible consolidation of functions which are presently duplicated. For example, procurement agencies have an Industrial Service Division, Small Business Division, Security Office, Contract Preparation Group, and Specification and Reproduction Center. These functions are identical in all Agencies, and can be consolidated. In some instances, Agencies are competing with one another. The Navy, Air Force and Army Industrial Service Divisions presently make separate facility surveys. This can be prevented by consolidation.

5 Consolidated bid lists can be posted at different locations for interested bidders, instead of lists pertaining to purchases of each Technical Service. Today a contractor must either subscribe to a commercial journal, pick up a Department of Commerce synopsis or arrange for a representative to personally visit an Agency in order to be informed of pending bids. It is an expensive operation and a duplication of effort to visit several Agencies simply to check bid availability.

Although some Agencies have field offices to disseminate information, this is not wholly satisfactory. The field offices do not always have complete specifications, bid forms, or more specifically lack technical personnel to discuss the job. Such personnel are generally only available at the Engineering Laboratory or Buying Office.

6 Security procedures would be standardized. At the present time, Central Intelligence Agency is supposed to handle overall security problems. The situation still prevails that a contractor will be cleared by one service and not by another.

7 Serious inspection bottlenecks would be broken. It has been consistently difficult for the contractor to obtain services of inspection personnel when material is ready for shipment. In many instances, companies have had to wait several weeks, after equipment has been produced, before inspectors visit their plant. This retards the defense effort and delays payment to the contractor. It also increases the Government's cost of equipment. Consolidation would materially improve the present setup. This becomes even more apparent when it is realized that in many areas an Army, Navy or Air Force inspector *will call simultaneously to conduct an inspection at the same plant.*

8 At times Services are at odds with other Services, in their efforts to obtain procurement responsibility for items which they feel belong in their jurisdiction. This produces unnecessary dissension and interferes with efficient performance. Unification of procurement would eliminate this type of service squabble. Employment of personnel who perform identical functions in each agency, i.e. hundreds of receptionists, messengers, clerks etc. would be eliminated thereby resulting in savings of millions of dollars to the taxpayer.

9 Considerable savings would be affected in overhead expense items. For instance, at the present time many agencies use different contract forms to make purchases. Such duplication would be eliminated. Printing and contract preparation functions would be combined. Reproduction equipment, IBM machines etc. can be pooled under an integrated procurement organization.

Characteristics of Precision Servo

Compared to radio-type pots, precision units feature higher torque. Finite resolution limitation of wire-wound element

By D. C. DUNCAN
Helipot Corp.
916 Meridian Ave.
South Pasadena, Calif.

IN the electrical engineer's original thinking, potentiometer was a contraction of "potential meter" indicating voltage measurement, and potentiometers accomplished this by comparing the test potential with a known potential. It should be understood that this paper concerns potentiometers only insofar as they are used for voltage division, nor does it reckon with the fact that these same potentiometers can also be used as rheostats or variable resistors. The accepted contraction or nickname for potentiometers quite naturally is "pot," and for brevity, this term will be used throughout this discussion.

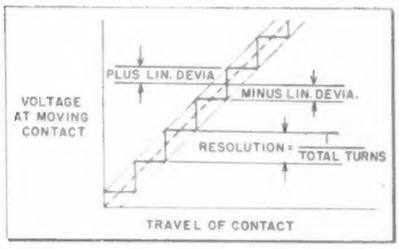


Fig. 1: Absolute theoretical accuracy of a wire-wound pot is limited to half of resolution

Precision pots are differentiated from the ordinary radio-type by their inherent features of better accuracy, freedom from electrical noise, longer life, lower torque and closer tolerances on physical dimensions. In present-day computing servo systems employing precision pots, all, or nearly all, of the electrical and mechanical characteristics govern the extent to which the pots may be applied and the results which will be obtained. This paper will discuss each of these characteristics and particularly point out those which, through a lack of understanding, can cause difficulty when pots are improperly engineered in circuits and systems.

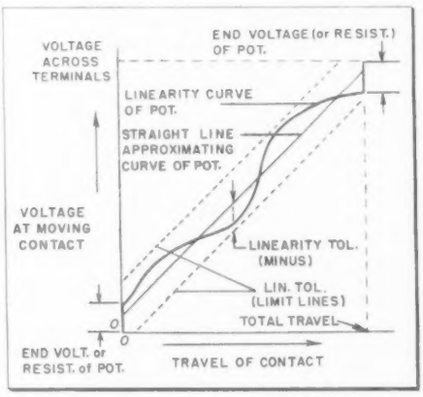

VOLTAGE ACROSS TERMINALS
END VOLTAGE (or RESIST.) OF POT.
LINEARITY CURVE OF POT.
STRAIGHT LINE APPROXIMATING CURVE OF POT.
VOLTAGE AT MOVING CONTACT
LINEARITY TOL. (MINUS)
LIN. TOL. (LIMIT LINES)
TOTAL TRAVEL
END VOLT. or RESIST. of POT.
TRAVEL OF CONTACT

Fig. 2: Normal linearity is defined by the voltage output at the potentiometer slider

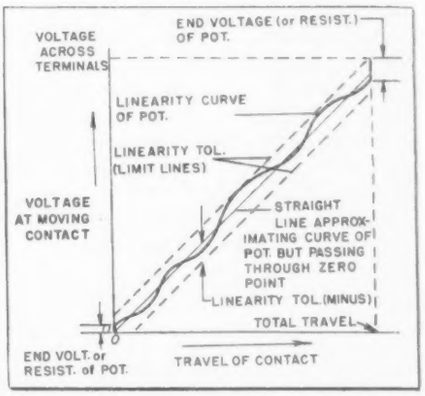

VOLTAGE ACROSS TERMINALS
END VOLTAGE (or RESIST.) OF POT.
LINEARITY CURVE OF POT.
LINEARITY TOL. (LIMIT LINES)
VOLTAGE AT MOVING CONTACT
STRAIGHT LINE APPROXIMATING CURVE OF POT. BUT PASSING THROUGH ZERO POINT
LINEARITY TOL. (MINUS)
TOTAL TRAVEL
END VOLT. or RESIST. of POT.
TRAVEL OF CONTACT

Fig. 3: For zero based linearity, line of zero error is adjusted to pass through zero point

Potentiometer Construction

It is hardly necessary to mention here that a pot consists of a resistance element having terminal connections at each end and a sliding contact which traverses this element from one end to the other. In current practice, the elements are of composition, deposited film, or wire-wound type. At the present stage of development, only pots of the wire-wound type are successfully manufactured with sufficient accuracy to fall into the category of what we are terming *precision* pots, although new work continuing in both composition and deposited film indicates that these types may soon approach or exceed the accuracies now obtainable with wire windings, and at the same time may introduce many other more desirable features.

A characteristic of a wire-wound element is that it produces finite steps of voltage, which are detectable as the range from zero to maximum voltage is traversed by the sliding contact. This is known as the resolution of the pot and is usually expressed in percentage . . . i.e. . . . resolution equals (1x100)/N; N being the total number of turns of wire.

Fig. 4: Proportional linearity has tapered tolerance limit, not applicable to wire pots

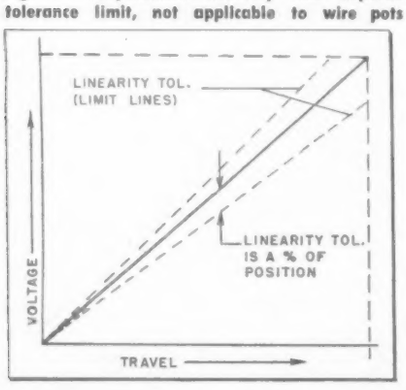


Fig. 5: Off-center brush arm introduces error because evenly spaced turns vary in length

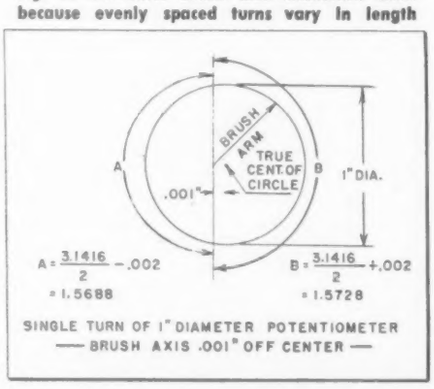
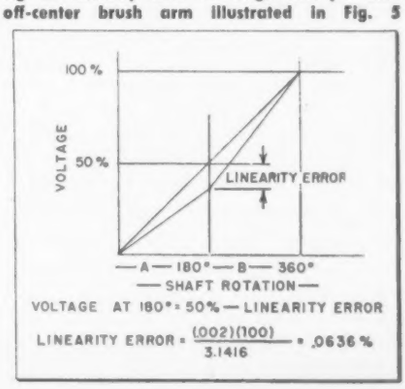


Fig. 6: Linearity error for single-turn pot with off-center brush arm illustrated in Fig. 5


100 %
50 %
VOLTAGE
LINEARITY ERROR
— A — 180° — B — 360° —
— SHAFT ROTATION —
VOLTAGE AT 180° = 50% — LINEARITY ERROR
LINEARITY ERROR = (.002)(100)/3.1416 = .0636 %

Computer Potentiometers

accuracy, less noise, longer life and lower indicates future use of deposited film

This finite resolution of the wire-wound pot is a condition which is never desirable, and which sometimes even prevents the satisfactory use of precision pots in certain types of circuits. Composition and film-type elements obviously have infinite resolution, and this is one of the reasons that further development in these fields may pay such big dividends. Better resolution in wire-wound pots is obtained simply by using more turns of wire about the mandrel, which in turn is accomplished either by using resistance wire of smaller diameter and hence crowding more turns onto a given length of mandrel, or by utilizing longer mandrels which can be coiled into a helical shape to conserve panel space. Other than these two approaches, resolution of a wire-wound pot can only be increased through a comparable increase in the physical size of the unit. To illustrate the wide range of resolution which is obtainable, consider the usual radio-type pot of up to 3 in. diameter and containing perhaps 500 turns of wire or ribbon, versus the precision-type pot of single turn design and equivalent diameter containing upwards of 5000 turns of wire; and lastly, the 40-turn Helipot of this same diameter containing more than 100,000 turns of wire.

Resolution Limits Accuracy

The absolute theoretical accuracy which can be expected of any wire-wound pot is limited by its resolution and, as illustrated in Fig. 1, this limit becomes one-half the resolution. If a theoretically perfect linear relationship between the voltage at the moving contact and the travel of the contact (or shaft rotation) were represented by the dotted line in this figure, it can be seen that the steps formed by each turn of wire would criss-cross such a line and that there would be inherently positive and negative excursions equal to one-half the resolution. In actual practice, of course, linearity accuracy of any pot can seldom, if ever, even approach this theoretical limit, and some of the practical reasons for this will be brought out after some consideration of the meaning of the term "linearity."

The word "linearity" itself, when referred to potentiometers, means, of course, a straight-line relationship between the voltage measured at the sliding contact and the rotation of the shaft. The amount that the output of an actual pot deviates from his straight line, in either a positive or negative sense, is the linearity error.

Linearity Definitions

Of the three more or less common linearity definitions, one can be said to apply strictly to potentiometer usage, while a second is more correctly associated with rheostat, or variable resistor usage, and the third can actually be applied to either pots or rheostats, and varies from the others only with respect to the meaning of the word "tolerance." The difference between potentiometer and rheostat interpretations of linearity is concerned principally with the orientation of the theoretical line of zero error, from which any deviations of the output of the actual pot are considered the linearity error. In the potentiometer definition, this theoretical line of zero error can be moved in space until it most nearly approximates the actual output curve of the pot under test. This interpretation was summarized by the radiation laboratories of M.I.T. as follows:

> "Potentiometer linearity tolerance shall be the maximum allowable deviation from the best straight line which can be drawn through the actual points of resistance on a resistance versus rotation graph. The tolerance shall be expressed in percent of total resistance."

While it is apparent that linearity accuracy and linearity tolerance of a potentiometer may be expressed in terms of resistance, it will be seen later that the actual measurement or test of linearity accuracy should be made in terms of voltage output at the slider, and tolerance thus means a percent of the total voltage across the element. This

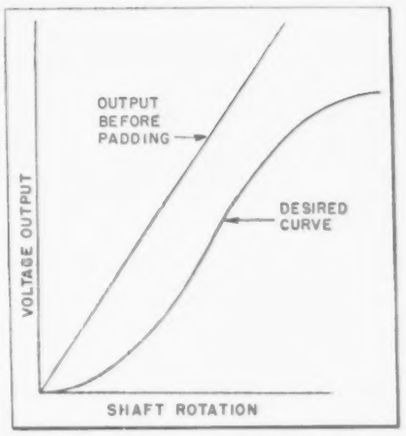


Fig. 7: Linear output of unpadded potentiometer

definition is known as "normal" linearity and is illustrated graphically in Fig. 2. It will be noted that the straight line representing theoretical zero error has been oriented in space to best fit the actual ouput curve of the potentiometer, and in so doing, this line does not necessarily pass through zero voltage at zero rotation, or total voltage at full rotation. The linearity tolerance limit lines would then define the area within which the actual curve of the potentiometer must remain to be in tolerance, and the tolerance itself is the distance above and below the line of zero error and is expressed in percentage of total voltage across the terminals.

Second Interpretation

The second interpretation of linearity is referred to as "zero based" and it specifically requires that the theoretical line of zero error pass through zero voltage output at zero shaft rotation, and sometimes also through total voltage at full shaft rotation. The latter situation adds, in effect, a fourth interpretation of linearity accuracy. The first form of zero based linearity is illustrated in Fig. 3, where the theoretical line of zero error has been adjusted so that it passes through zero voltage at zero rotation, but not through total voltage at full rotation. In this linearity definition, the tolerance is still understood to be expressed as a percentage of the total voltage or total resistance.

The third interpretation is usually referred to as "proportionality" or "proportional linearity," and this actually affects only the interpretation of tolerance itself, and it can apply to either normal or zero based definitions of linearity accuracy. Proportionality requires that the tolerance, instead of being a percentage of total voltage, be a per-

centage of the value at any position of the slider; that is, at one-third of the total shaft rotation the tolerance would be a percentage of the voltage output at that point, and similarly, for any other slider position. The result is a tapering of the linearity tolerance limit lines as illustrated in Fig. 4. Since it is apparent that the linearity tolerance reduces to plus or minus zero percent at one end of rotation, it is obvious that this interpretation cannot be applied with any reality to a wire-wound potentiometer containing finite steps of voltage change.

Uniformity of Mandrel

As mentioned earlier, linearity accuracy is theoretically limited to one-half the resolution in wire-wound pots, while practical considerations of design and manufacture actually limit maximum accuracies to much larger values. These considerations naturally include the characteristics of the resistance element itself, which depend upon the uniformity of the mandrel or card on which the wire is wound, the uniformity in cross-section of the resistance wire, the

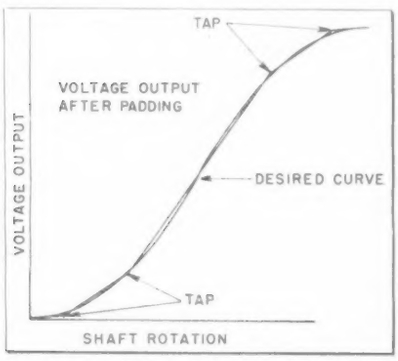


Fig. 8: Output of padded pot is broken into series of straight lines to get desired curve

resistivity of the alloy from which the wire is formed, and lastly, the accurate positioning of each turn of the wire in the coil. All of these variables are simultaneously controlled, at least to some degree, by automatic variable positioning of the individual wire turns as the coil is wound, and it is hence sometimes possible to obtain somewhat better accuracy in the winding itself than the characteristics of the resistance wire and mandrel might indicate.

However, even were it possible completely to control these factors in the winding of the element, and thus produce with regularity coils having accuracies equal to one-half the resolution, the pot manufacturer is still faced with the very practical problem of assembly of his product, which may have a radical effect on the accuracy of the completed unit. Figs. 5 and 6 give a better appreciation of the possible extent of linearity errors which might be caused by mechanical inaccuracies in the pot design or construction. This illustrates the situation of a single-turn pot of one-inch resistance element on a shaped card, which has been formed so that each turn of wire, while equally spaced from adjoining turns, presents a greater or lesser voltage change than its predecessor by the fact that the individual turns vary in length. Other manufacturers wind the resistance wire upon a mandrel of uniform diameter and circumference, but obtain the variable slope between voltage output and shaft rotation by varying the spacing between individual turns of wire and even, in some cases, splicing in resistance wires of different alloys or different sizes.

Greater Accuracy

A third approach is sometimes used where greater accuracy and smoothness is desirable and where the slope of the desired curve does not vary radically at any point. This method utilizes cams which have been shaped according to the desired curve and which are either introduced into the driver of the pot shaft, or which move the coil itself independent of rotation of the shaft. A fourth method, and one which is used widely in experimental set-ups where it is frequently desirable that the original output curve be modified to meet changing circuit requirements, involves the resistance or voltage loading or padding of the resistance element by means of tapped connections. In this approach the desired curve is actually approximated by a series of straight lines, which represent the linear resistance element between each set of taps. The slopes of these straight lines will be determined by the amount of voltage or resistance padding connected to the taps. This approximation of the desired function by resistance or voltage padding is illustrated in Figs. 7 and 8, Fig. 7 showing the linear output of the original potentiometer in contrast to the desired curve, and Fig. 8 how the output of the potentiometer has been broken up into a series of straight lines, each approximating the slope of the desired curve over the respective portions of that curve.

Functional potentiometers fill an important need which is continuing to grow in the application of pots to servo-computers. The use of these pots frequently greatly reduces or eliminates the need for extravagant gear trains or cam devices either to provide functional output or to correct for non-linear signal inputs.

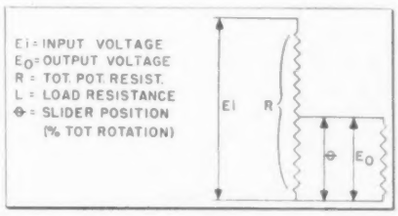


Fig. 9: High load resistance reduces slider current with its accompanying loading error

A problem which exists to some extent in all pots, regardless of the type of element, quite often causes difficulty in highly sensitive circuits. This problem is concerned with an electrical noise, consisting of rapid voltage fluctuations caused by varying resistance between the sliding contact and the resistance element, as the shaft of the pot is rotated. In wire-wound pots, a portion of this voltage fluctuation is inherent as a result of the steps caused by the turns, called resolution noise, while in all types of pots, most of the balance of the noise is caused by foreign material coming between the sliding contact and the resistance element. This is referred to as transient noise. It is obvious that nothing can be done to reduce or eliminate the fluctuation in wire-wound pots caused by the individual turns, and this is negligible in most cases anyway in comparison with the noise caused by interference of foreign material. This material is of two types, one being simply dirt of all kinds, and the other an oxide film which forms on the surface of the resistance wire itself. The elimination of the dirt is principally a question of sanitation during the fabrication and assembly of the pot and suitable dust-tight sealing of the pot enclosure to prevent the entrance of dirt after it is installed in the equipment. Even when these considerations are properly cared for, most pots will have a tendency to create their own internal dirt by the fact that the various parts will wear and deteriorate due to friction as the unit is operated.

(*Continued on page* 94)

E-C Glass Resistors

Extremely stable components show less than 0.2% resistance change in thermal cycling between –55°C and 200°C

By *JAMES K. DAVIS*
Corning Glass Works, Corning, N. Y.

THE electrical and thermal stability of E-C glass resistors opens the door to reliable resistor operation at high ambient temperatures, high power levels, and at high frequencies. E-C glass resistors are film-type resistors developed by Corning Glass Works. The properties of the resistors are derived from the unusual properties of the E-C conductive coating bonded to a durable, heat-resistant glass. Although this coating is very thin—of the order of a wavelength of light—it is extremely tough, highly adherent, and is resistant to strong acids, alkali, and moisture. It is electrically stable over a wide temperature range, as is evidenced by the fact that it can be cycled in air from temperatures near absolute zero (—273°C) to a red heat without impairing its conductivity. All these properties are inherent in the film coating itself and are not imparted to it by protective coverings.

The construction of these resistors is briefly as follows. The resistive element is the E-C conductive coating, which is bonded permanently and integrally to a heat-resistant glass rod or tube. Resistances above a few hundred ohms are obtained by grinding a helical path in the conductive coating. Contact is afforded by silver terminal bands which are fired onto the coating at a red heat thereby insuring a permanent connection. A silicone varnish is usually applied over the resistor to give mechanical protection and to facilitate marking. Initial resistance tolerances of ±0.5% are possible, although standard tolerances will probably start at ±1%.

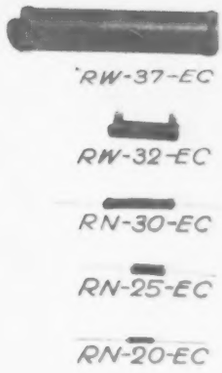


Fig. 1: Representative glass resistors range from 45-watt radial lead to ½-watt axial type

Representative Corning resistors are shown in Fig. 1. The resistors shown range from a ½-watt axial-lead unit to a 45-watt radial lead tubular power unit.

To assist in evaluation of the potentialities of these resistors, information is presented on the following properties: electrical stability, temperature and voltage coefficients of resistance, moisture resistance, and high frequency characteristics.

Load-Life Data

Load-life data on two 10,000 ohm resistors operating at a surface temperature of 200°C. are shown in Fig. 2. The maximum resistance change in 700 hours at this temperature was less than 2%. The resistors are also stable under thermal cycling. Repeated cycling between 200° C and –55°C altered the resistance value by less than 0.2%. This electrical stability at 200°C makes it possible to operate at higher ambient temperatures and at higher wattage ratings than has been feasible heretofore. It also indicates potentialities in the direction of miniaturization.

Fig. 3 illustrates the electrical behavior of these resistors when operated down at conventional temperatures and power levels. This load-life data is for two 50,000 ohm resistors operated at 125°C surface temperature. The maximum change in resistance during the 500-hour test was less than 0.2%.

The temperature coefficient of resistance is less than 200 parts per million per degree C. Laboratory samples have been prepared with

(*Continued on page* 120)

Fig. 2: Load life characteristics of two 10,000-ohm resistors at 40°C ambient, 200°C operating

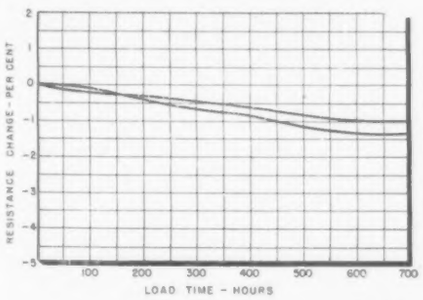


Fig. 3: Load life characteristics of two 50,000-ohm resistors at 40°C ambient, 125°C operating

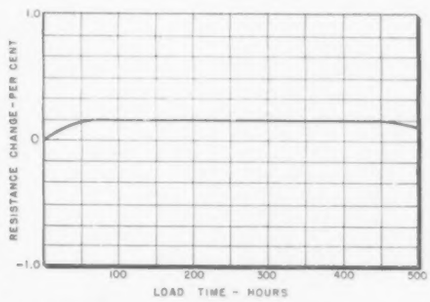


TABLE I: E-C GLASS ACCURATE RESISTORS

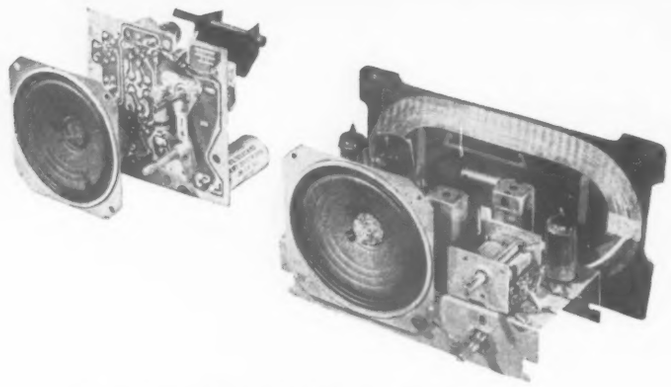
Type	Size (in inches) O.D.	Size (in inches) Length	Resistance (ohms) Min.	Resistance (ohms) Max.	Power Rating at Ambient Of 120° C	Power Rating at Ambient Of 40° C
RN-20-EC	11/64	19/32	10	10,000	1/2 W	1 W
RN-25-EC	19/64	15/16	10	40,000	1	2
RN-30-EC	19/64	2-1/16	20	100,000	2	4

TABLE II: E-C GLASS POWER RESISTORS

Type	Power Rating	Size (in inches) O.D.	Size (in inches) Length	Resistance (ohms) Min.	Resistance (ohms) Max.
RN-30-EC	4 W	19/64	2-1/16	20	100,000
RW-31-EC	6	9/16	1-1/2	20	70,000
RW-33-EC	11	9/16	3	20	150,000
RW-35-EC	21	7/8	4	20	300,000
RW-37-EC	45	1-1/4	6	20	500,000

Plated Circuit

Economical manufacturing method

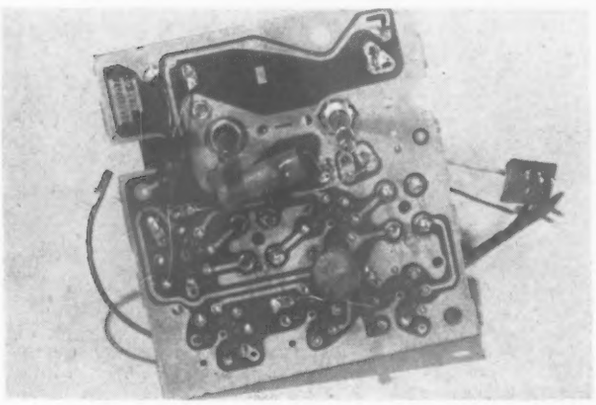


First mass-produced plated-circuit radio is Motorola's newest 1952 model shown on the left. Fabricated by machines using the "Pla-cir" process, it shows considerable size and weight reduction over the conventional 1951 model on the right, which contains the same number of tubes and essential components

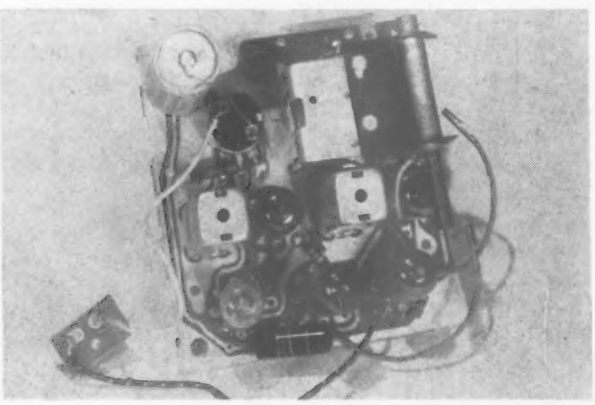
AFTER six years of research costing $1,000,000, Motorola has placed in operation a new mass production system of manufacturing radio receivers. The new printed circuit method, called "Pla-cir," replaces the conventionally bulky chassis with a compact and lightweight bakelite base, upon which the circuit is plated and components are mounted.

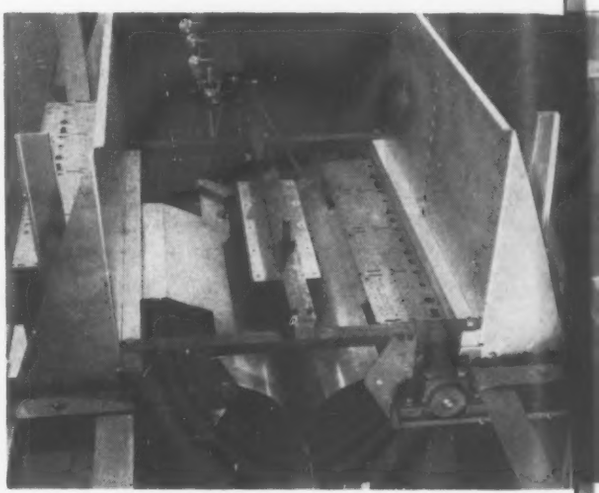
Production operations are essentially accomplished by machine. Punched bakelite strips are fed by conveyor through stations which prepare the surface, coat the strip with a conductive film, and print a resist material from a photographically-prepared stencil. A thin copper foil is then electroplated on the prepared base, and a subsequent operation removes the areas of resist and underlying conductive coating, leaving the desired circuit configuration.

Of particular interest is the fact that the circuit is continuous from one punched hole to the other, and through the hole to the other side of the base. Where it is not desired that copper plating run through the



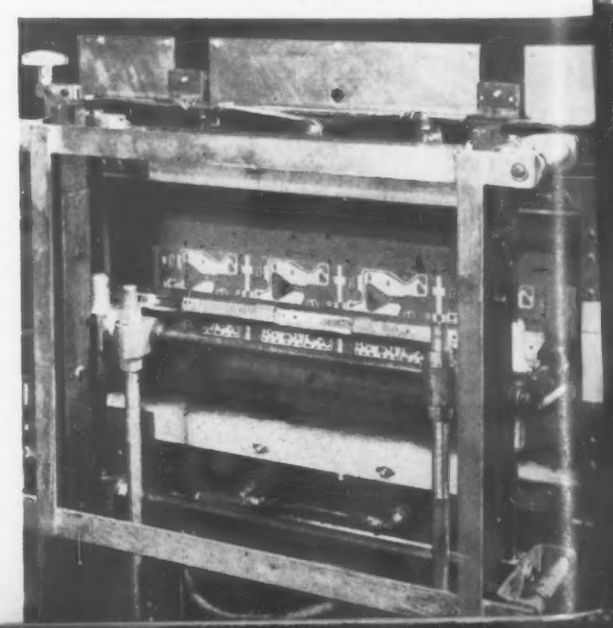
Top and bottom views of the plated-circuit chassis shows the copper layer configurations, spot-soldered connections, and components on the bakelite base





1 Starting point in the "Pla-cir" process is the criss-cross strip feed mechanism. The punched bakelite strips are transferred to an input drive conveyor

4 In the printer, each strip is passed between stencils and automatically printed with a resist. The arrival of a new strip ejects the printed unit.



Process for Radio Production

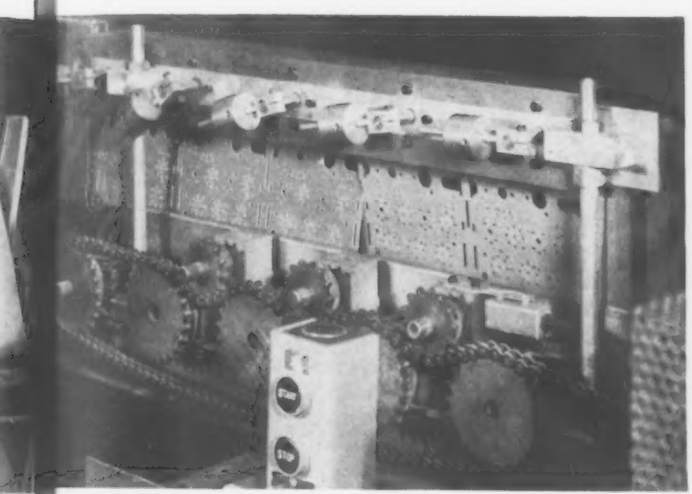
plates copper conductor on both sides and through base

hole to the other side, partially punched holes are made. Slugs are left in these holes until plating is finished, and pushed out later by dies. Holes are specifically located in the base layout to accommodate the mounting of tubes and other components.

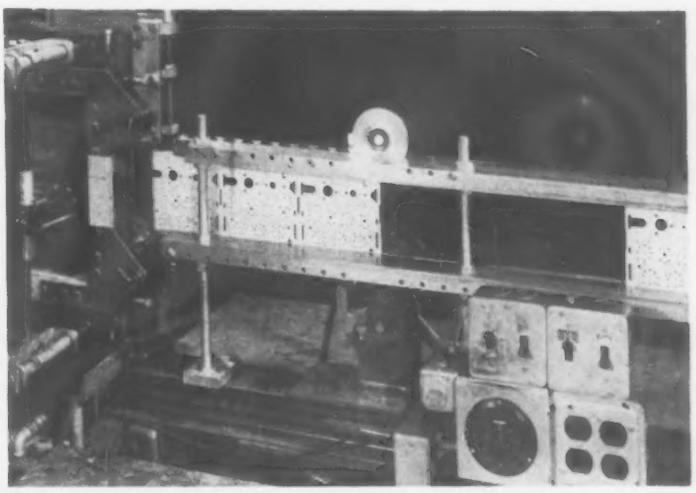
Automatic Spot Welding of Parts

Concurrent with automatic placement of components is the automatic spot soldering of parts, further aiding mechanization of assembly. This approach overcomes the limitations of other soldering methods which place solder on conductors on the opposite side. Clips for holding tubes are either soldered in terminal holes, spring-bite mounted in metal lined holes, or set in unplated holes with tangs soldered to adjacent terminal holes.

Although initially applied to flat shapes, the "Pla-cir" method may be used to make three-dimensional units. However, it is believed that plane bases are the most practical approach, because solid shapes can be formed by joining plane sections.

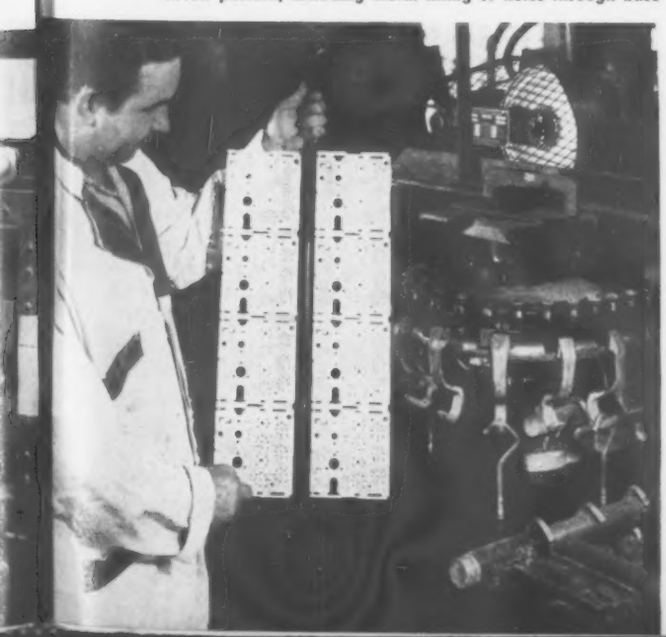


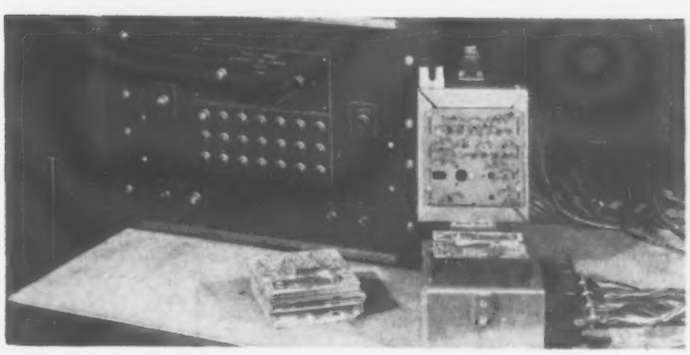
2 The input drive conveyor pushes the strips into cabinets which process the base surfaces



3 From processing, the strips are advanced to the printer by a wheel run at a higher speed than the input drive

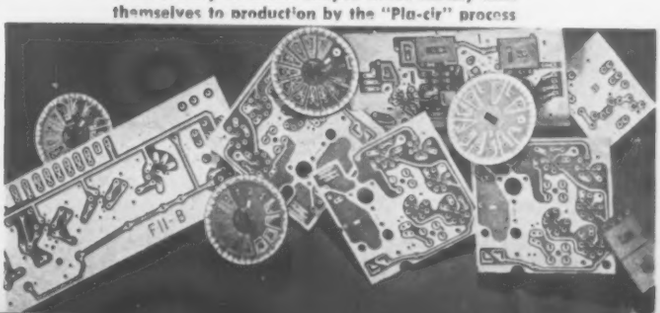
5 After printing, the strips are racked in pairs and electroplated. A later stage removes resist areas, leaving copper circuit pattern, including metal lining of holes through base





6 Finished and cut apart, the basic chassis is checked in two seconds by a stepped test set for leakage, shorts and opens

7 Wide variety of circuit shapes which readily lend themselves to production by the "Pla-cir" process



Resistance-Capacitance Loading of

New method of analyzing a current wave of any shape under various circuit conditions. Graphic approach

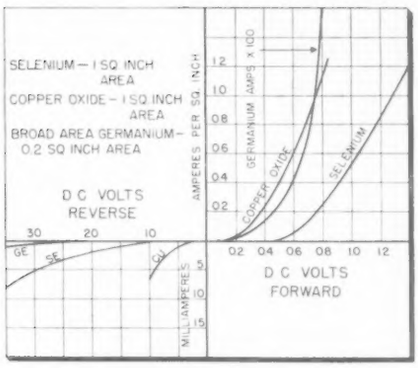


Fig. 1: Static volt-ampere characteristics of selenium, germanium and copper oxide rectifiers

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General Electric Co.
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IT is the common practice of the manufacturers of metallic rectifiers to assign output ratings in terms of dc values of voltage and current. This practice came about naturally because the principal purpose is to change ac to dc and the user is primarily interested in the dc output that will be delivered by a given rectifier.

The current rating usually is the value in average amperes which the rectifier will deliver safely when operated in a prescribed circuit into a load consisting of resistance only. For selenium, most manufacturers have agreed on a dc current rating of 320 ma/sq. in. in a single phase, full-wave bridge with resistance load. In fact, this rating has been tentatively standardized by NEMA.

Present-day applications frequently involve loads which contain a substantial amount of capacitance. The question naturally arises as to the effect on the heating of the rectifier and what derating should be applied to prevent any heating in excess of that which occurs under the prescribed conditions of resistance loading. Many manufacturers prescribe derating to 80% of normal dc rating when the load contains capacitance. This magic figure has come down through the years as a result of practical experience. Other manufacturers suggest that the rms value of current be held to the same value as occurs in resistance loading. This rule leans strongly toward the side of safety but will penalize the utilization of the rectifier by derating considerably more than is necessary to maintain normal heating.

We normally think of the rms current as a measure of heating. This is true where the resistance of the device remains a constant value. In a selenium cell the forward resistance is nonlinear. The resistance decreases as the current rises. In the expression I^2R, the value of R constantly changes as the forward current rises and falls in any particular shape of current wave. Depending on the shape of the current wave through the cell and the period of conduction, the I^2R loss may vary considerably, even though the rms current is held to the same value.

It is the purpose of this paper to show a method of analyzing graphically a current wave of any shape and relating the heating to that which occurs under the prescribed condition of "normal" rating.

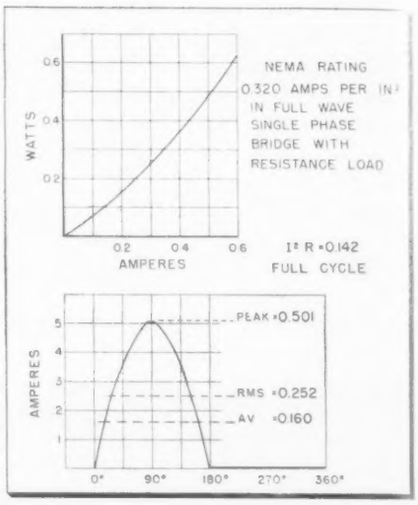


Fig. 4: Current wave and power in one arm of a bridge operating from sinusoidal ac supply

Fig. 2: Selenium current-resistance curve

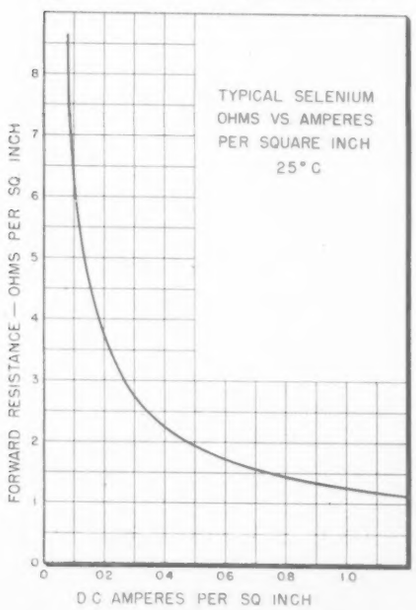
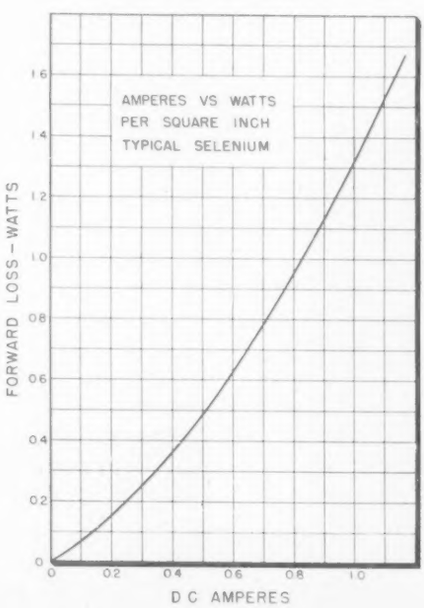


Fig. 3: Instantaneous current-power curve



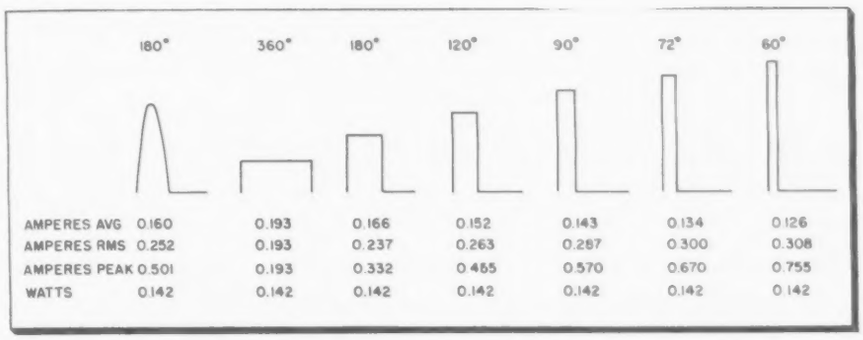
Volt-Ampere Characteristics

Fig. 1 shows the static volt-ampere characteristics of three types of metallic rectifiers. The rapid rise in current with respect to voltage indicates the nonlinear resistance characteristics apparent in all known types of metallic rectifiers, including the area-type germanium, the newest addition to the metallic rectifier family.

Fig. 2 shows the selenium amperes vs. ohms curve per 1 sq. in. of active area. Using the data from Fig. 2, a curve may be plotted showing the instantaneous values of amperes vs.

Selenium Rectifiers

evaluates rectifier heating and required derating increases utilization of maximum power capabilities



	180°	360°	180°	120°	90°	72°	60°
AMPERES AVG	0.160	0.193	0.166	0.152	0.143	0.134	0.126
AMPERES RMS	0.252	0.193	0.237	0.263	0.287	0.300	0.308
AMPERES PEAK	0.501	0.193	0.332	0.465	0.570	0.670	0.755
WATTS	0.142	0.142	0.142	0.142	0.142	0.142	0.142

Fig. 5: For 0.142 watts/sq. in., current waves with different conduction periods are graphically shown

the instantaneous values of watts (I^2R forward loss within the cell). See Fig. 3. Here we have a tool for analyzing any shape of current wave and determining the corresponding heating.

For example, Fig. 4 depicts the current wave in one arm of a bridge when operating from a sinusoidal ac supply into a resistance load at the NEMA rating of 320 ma/sq. in. The wave shape closely approaches a sine wave and the ratios of dc to rms to peak are very nearly the theoretical values. If 320 ma represents the output of the bridge, then any one arm of the bridge must pass an average current of 160 ma for the full cycle. This proves in this example to be 0.142 watts per square inch of cell area. Any shape of current wave can be analyzed in the same manner and the resulting watts compared with this established normal to determine if the forward heating is excessive. This method of analysis may be applied to any make of metallic rectifier, providing the ampere-ohms curve is prepared for the make under consideration.

Fig. 5 gives a graphic presentation of current waves with various periods of conduction. Again a value of 0.142 watts/sq. in. derived from the

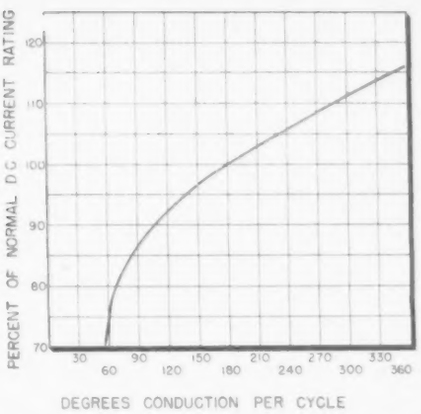


Fig. 6: Effect of conduction period on derating

NEMA standard is used as a "yardstick" and in each case this value of watts is held at the same value for the full cycle. It is apparent that with shorter conduction periods and correspondingly higher peaks, the dc (average) current decreases and the rms current increases, with no change in the I^2R loss.

Capacitance Loading

For any condition of resistance-capacitance loading, the reduction in length of the period of conduction will serve as a measure of the derating in dc (average) amperes necessary to maintain normal heating, as shown in Fig. 6.

We now have a logical means for derating providing we know the length of the period of conduction. The drop in capacitor voltage determines the point where conduction

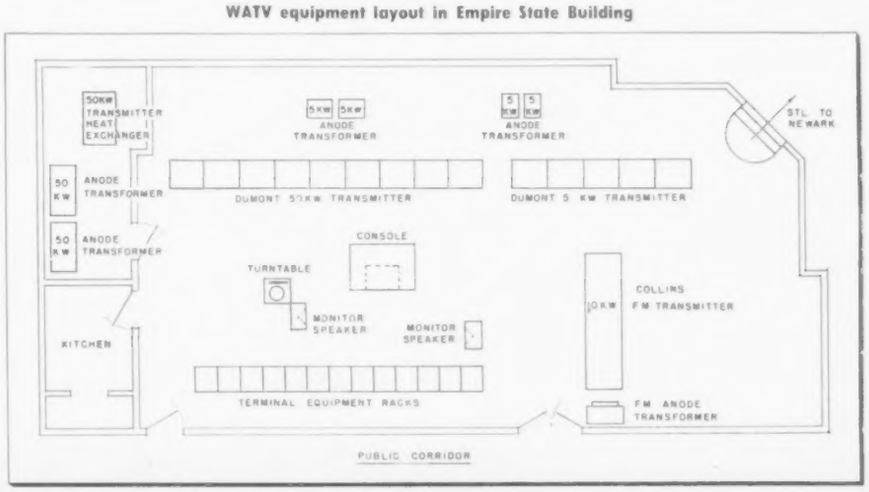
(*Continued on page* 134)

WATV Moves Transmitter Location to Empire State Building

TO provide broader telecasting coverage, WATV is moving its transmitter location to the Empire State Building in New York City. The channel-13 station joins five other TV installations and three FM presently operating atop the structure. Construction work is progressing, and should be completed at the beginning of 1953.

The accompanying diagram shows the layout of equipment on the 83rd floor. In addition to the 5-kw transmitter which will start operation immediately upon completion, a DuMont 50-kw unit is being installed in anticipation of FCC authorization of higher power. A microwave system provides the transmission link between the WATV transmitter and studios in Newark, N. J. Other features in the new installation include a 10-kw Collins FM transmitter and an Andrews 12-element skewed antenna on each of the four corners at the top of the mooring mast, 1200 ft. above street level. With an antenna gain of 5, the ERP will be 25 kw video, and 12.5 kw audio. When the 50 kw transmitter is put into operation, power will be raised to 178 kw ERP.

WATV equipment layout in Empire State Building



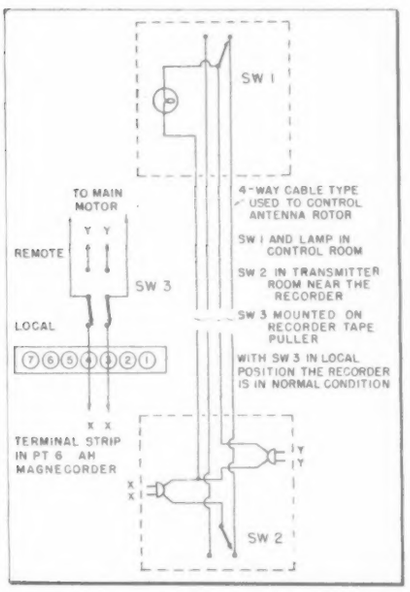
CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Remote Start-Stop System

J. M. SHERWOOD, Jr., Chief Engineer, WRCS, Ahoskie, N.C.

A Magnecorder PT 6 AH is located in our transmitter room, and announcers who are putting tapes on the air are in another room. A signal light is included in the remote start-stop system which we use to remind the announcer to


SW 1
TO MAIN MOTOR
4-WAY CABLE TYPE USED TO CONTROL ANTENNA ROTOR
SW 1 AND LAMP IN CONTROL ROOM
SW 2 IN TRANSMITTER ROOM NEAR THE RECORDER
SW 3 MOUNTED ON RECORDER TAPE PULLER
WITH SW 3 IN LOCAL POSITION THE RECORDER IS IN NORMAL CONDITION
REMOTE
SW 3
LOCAL
7 6 5 4 3 2 1
TERMINAL STRIP IN PT 6 AH MAGNECORDER
SW 2

Announcer operated tape reproducers can be remotely controlled by engineer if necessary

stop the machine after the tape has been used. The engineer on duty cues in a tape well before it is to be placed on the air, *then forgets about it.* The announcer closes his switch and starts the tape when he is ready. Of course the engineer will leave the clutch mechanism engaged and ready to go as part of his cueing procedure. A plug type arrangement is used for coupling to the external switching circuit to facilitate using the recorder at other locations.

Eliminating Preamplifiers

J. DAVID BODELL, WCCM, 278 Essex Street, Lawrence, Mass.

WE at WCCM are of the opinion that many stations now operating with turntable preamplifiers, can do without them. Our patience became exhausted with microphonic and noisy preamp tubes, hum, poor quality, constant trouble shooting, and messy turntable interiors. The trouble was traced to our preamplifiers and their associated pads, transformers, etc.

In an effort to end our troubles, the preamplifiers and everything else between the pickups and consoles—excepting the scratch filters—were eliminated. It was found that we still had plenty of gain, quality was faultless, no microphonics, operation was simplified. There was, however, a small amount of hum, but this was entirely eliminated by not grounding either side of the pickup lead-in wire.

$$$ FOR YOUR IDEAS

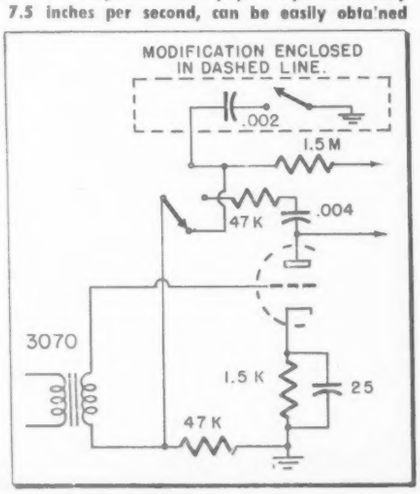
Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, doubled-spaced text is preferred. Our usual rates will be paid for material used.

Improved Response from Paper Tape

L. H. CRUMBAUGH, KGER, Long Beach, Calif.

THIS system is adaptable to any of the PT-6 series of Magnecord amplifiers and has the following advantages: (a) flat response on *paper* tape at 7.5 i.p.s. to beyond 6500 cps, therefor important savings in tape costs where permanent tapes must be kept; (b) response better than so-called "class-A" remote circuits, (c) moderate boost available when used as remote amplifier; (d) *no* change in playback channel. The feedback around the first stage is altered in the "Record" and "Amplifier" positions of the functions switch.

6.5 KC response from paper tape with only 7.5 inches per second, can be easily obta'ned



Parts required are a SPST switch and a .002 uf condenser of good quality. The switch is panel mounted to indicate "Paper tape" and "Plastic tape". The condenser is in the circuit for paper tape. A further advantage to the busy control room technician is the fact that no extra step is involved in quick switching from "Record" to "Listen".

Electric Door Lock for Station Control Room

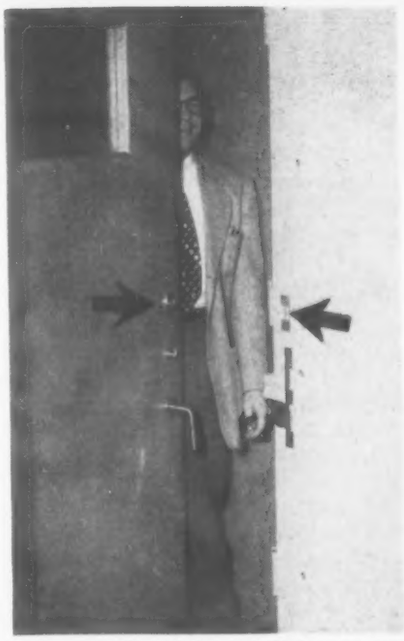
HERBERT G. EIDSON JR., Chief Engineer, WIS, Columbia, S. C.

STANDARD door locks usually operate on ac and hold the door unlocked as long as the controlling button is pressed. The person wanting admittance must wait until the energizing button is pushed. The button must be kept in this position until the door has opened past the locking position. During this time, there is a loud annoying buzz. Two improvements have been effected simply, and at little cost, by the use of a time-delayed circuit, and insertion of dc on the lock magnetic holding coil.

The illustration shows the opened door, and the arrow on the right points to the magnetic lock with roller. This is a catch, its lip being a roller. This catch remains in forward position (toward door) and is immovable when not energized. The door can be opened, when its coil within receives 6 v., the catch is free to be pushed into its brass case, which is done by the spring loaded brass piece protruding from within the door.

The schematic shows the circuit. As this station already was utilizing a heavy duty 24 v. dc supply to handle 30 relays, it was not necessary to build another to obtain this needed voltage for the new project. However, a 6 v. dc supply was built using a copper oxide rectifier with a rating of only two amps which required the use of a slightly higher voltage on the transformer secondary due to greater voltage drop within the copper oxide. Since the service is not continuous, no harm results from the slight overload.

When the spring loaded switch



Silent operating electric door lock with time delay eliminates need to "hold" operating button

(button) is pressed, 24 v. dc charges the 1000 μf capacitor through a 200 ohm resistor. The resistor is necessary to isolate the heavy initial load of the capacitor from the power supply. If this were not done, the many external relays which this supply feeds would drop out, for the voltage would drop to a very low value at the instant the button was pressed. The time-constant of the RC combination during charge is 0.2 sec., since TC is equal to RC, RC being in units, TC being in seconds. This means that the button has to be pushed and held for only 0.2 sec. When it is released, another RC circuit comes into operation. This is the original 1000 μf capacitor discharging 24 v. through the 10,000 ohms resistance of the relay. The theoretical time-constant of the circuit is 10 sec., but due to the relay falling out before the condenser has lost 36.8% of its initial charge, the practical TC becomes about four seconds. This means that when the button is released, the relay holds for 4 sec., the magnetic lock opens for the same amount of time thus giving a person entering plenty of time to open the door.

When the lock loses its magnetic energy, the door cannot be opened from either side unless the button is again pressed, or the small handle on the door is rotated from inside, thus mechanically by-passing the magnetic lock. This can also be rotated from the outside of the door, using a key. This is a safeguard in case of power, or equipment, failure or if the operator locks himself out.

Program Delay System

KEN MAXWELL, Chief Engineer, KLTI, Longview, Texas

RECENTLY, at KTLI, it became necessary to delay baseball broadcasts received from the network for a period ranging from 30 minutes to one hour before rebroadcast. The problem was solved through the use of two Webster Chicago tape recorders.

The Webcor is a dual track recorder which may be manually reversed, making switching of the reels unnecessary. Program from the network line is fed continuously to both recorders. The output circuits are fed through a matching transformer to the console input. Each machine records a complete "circle" down one side and back on the opposite track, then reproduces over the same route. The other machine records while the first is playing back and vice versa.

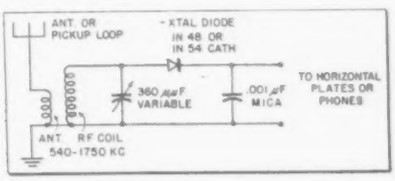
For example, a delay of one half hour is obtained as follows: Recorder #1 begins recording at the start of the program and records with the tape moving to the right. After exactly 15 minutes the tape is reversed so that it makes the return trip still recording. At 30 minutes the tape machine is switched to playback and the direction is again reversed. Simultaneously machine #2 starts recording. At 45 minutes both machines are switched in direction only. At 60 minutes both machines are switched in function and direction. This continues with changes in direction being made every 15 minutes and changes of function every 30 minutes.

Delays other than 30 minutes may be obtained by shortening or lengthening the time between reversals proportionally. The time between reversals in one half of the delay time. It was found necessary to remove the ground connection in the output cable to each recorder to prevent cross talk due to a loop in the ground circuit.

Trapezoid Pattern Indicator

GEORGE DODGE, Chief Engineer, WFOX, Milwaukee, Wis.

AN economical, trapezoid indicator can be constructed as shown in the illustration. It consists of a simple crystal receiver, the output of which is fed to the horizontal


ANT. OR PICKUP LOOP
-KTAL DIODE IN 48 OR IN 54 CATH
TO HORIZONTAL PLATES OR PHONES
360 μμF VARIABLE
.001 μF MICA
ANT. RF COIL 540-1750 KC

Simple crystal receiver circuit turns oscilloscope into modulation and waveform monitor

plate of an oscilloscope. The vertical plates of the 'scope are connected directly to an r-f pickup loop or an antenna. With the 'scope set to accept proper frequencies a trapezoidal modulation pattern will be produced indicating the modulation depth. A further refinement would be to mount the receiver inside the oscilloscope making connections with coaxial cable. To obtain a clean pattern on the 'scope the RF signal used should be the minimum required to give a usable presentation.

Single Input-Output Connection

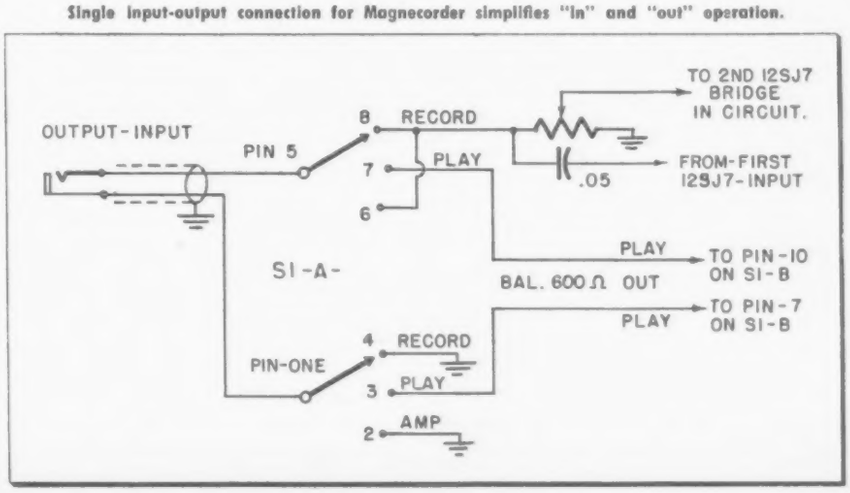
SAM DUDAS, WBRD, Fort Lauderdale, Fla.

TO avoid the necessity of changing jack connections when switching from "record" to "play" with the PT6J Magnecorder WBRD uses the circuit shown in the diagram.

The resistors and connection are completely removed from S1-A, mounted on a terminal connector,

(Continued on page 102)

Single input-output connection for Magnecorder simplifies "in" and "out" operation.



Telemetering and Direct Frequency

Communications engineering techniques applied to remote measurement systems. Comparative evaluations made of operation, accuracy and time of AM and FM instruments

By PAUL M. ERLANDSON
Southwest Research Institute
8500 Culebra Road
San Antonio, Texas

IN general, the methods of measuring the amplitudes of both dc and ac voltages and currents may be classified as follows:

Comparison with Voltage and Resistance Standards: Both voltages and currents are usually measured by direct comparison with secondary standards of voltage and resistance where extremely high accuracy is necessary. The most common instrument used for such comparison is the potentiometer. For ac measurements, a transfer instrument of a type giving equal indications for ac and dc voltage equivalents must be used. In general, accuracies on the order of 0.02% may be obtained, using relatively complex equipment. Measurement time is not as short as with direct indicating instruments.

Response of Calibrated Electromechanical Systems: Under this classification can be included precision instruments such as the Rayleigh balance for absolute current measurements, electromagnetic instruments such as galvanometers, electrostatic instruments, and thermal types. These are essentially direct-indicating instantaneous instruments. Typical accuracies which can be obtained are: precision dc galvanometer, 0.1%; laboratory standard dc voltmeter, 0.25%; portable ac voltmeter, 0.3%; switchboard voltmeter with scale over 5 in., 1.0%.

Many other methods of making amplitude measurements have been described in the literature. Since amplitude meters are not at present a major problem in instrument communications systems, emphasis here is placed on frequency system meters.

Frequency Meters

General methods of making frequency measurements may be classified as follows: Comparison with Frequency Standards; Comparison with Time Standards; Response of Calibrated Electromechanical Resonator; Response of Calibrated Electrical Circuits; Conversion to Amplitude Measurement.

Examples of each type of system are in practical use and are discussed here briefly.

Comparison with Frequency Standards: The CRT and stroboscopic methods are capable of high accuracy, and may be incorporated into completely automatic systems. In the CRT frequency meter, for frequencies of the same order of magnitude, it is usual to apply the standard to one set of deflection plates and the unknown to the other set. This method produces a Lissajous figure from which the frequency ratio can be estimated with essentially the accuracy of the standard frequency. If the frequency ratio is large, the lower frequency may be used to deflect the CRT trace in a circle and the higher frequency used to modulate an accelerating electrode, producing a gear-shaped pattern, or to modulate the control grid, producing a circle of dots or small arcs which may be counted to determine the ratio.

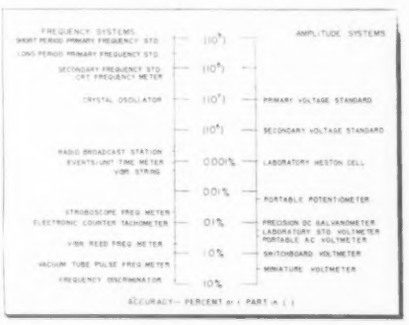


Fig. 4: Comparison of measurement accuracies obtainable in frequency and amplitude systems

The stroboscopic frequency meter gives direct indication of frequencies between 32 and 4186 cps with an accuracy of 0.05%. An adjustable tuning fork with sliding weights calibrated in 100 steps drives a synchronous motor. The motor is geared to 12 pattern disks, each translucent and bearing 7 concentric rings with 2 in. black and white segments in each ring. Gear ratios are chosen so that successive disks vary in speed by the twelfth root of two. To measure a frequency, a discharge lamp which illuminates the disks is driven by the unknown. The tuning fork is adjusted until the pattern is stationary, whereupon the input frequency is read from the tuning dial. Although the primary range is only about 130:1, external frequency dividers can be used to extend it.

Comparison with Time Standards: The instruments described under this heading are basically similar and offer great promise for instrument communications. Further development work should reduce their size, weight, and relative complexity to a point where they will find routine use as process meters, with one meter used to handle a number of

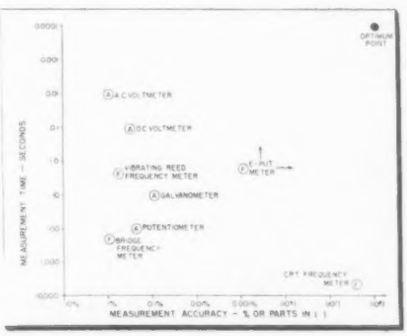


Fig. 5: Time-accuracy comparison for frequency (F) and amplitude (A) measurement systems

transducers. Since measurement of a frequency can be made in one half period, rapid controls can be operated by many audio frequency transducers through one meter.

Counting Meter

The Events Per Unit Time Meter will count events occurring at rates from 50 to 100,000 per second with an accuracy of 1 unit and a short-term stability better than 1 part in 10^5. The events to be counted must be converted into voltage pulses. Indication is made directly in decimal digits on a bank of panel lamps. An associated mechanical register may be used to count as high as 10^{10}. Measurement of frequency is accomplished by an internal device which turns on the counter for exactly 0.1, 1, or 10 seconds. The instrument can be used continuously to count for one second, display an indication for one to five seconds and automatically recycle.

Measurement

PART TWO
OF TWO PARTS

The High-Speed Chronoscope is an electronic clock which measures and indicates time intervals from 10 μ sec to 3 seconds, a ratio of 300,000:1, in eight ranges. Accuracy is about 1% of full scale. External information as to start and stop times must be introduced. A mechanical pointer is coupled to a motor-driven potentiometer which measures the charge lost from a stable capacitor through a stable resistor during the time the resistor is connected to the capacitor by an electronic switch.

The Chronoscope Calibrator is used with the chronoscope, allowing direct measurement of frequency by converting one cycle of an input signal into a single pulse of length directly proportional to the duration of the cycle. Conversion accuracy is stated to depend only on the incoming signal.

The Electronic Counter Tachometer measures frequencies from about 4 to 1600 CPS by counting impulses from an external source during a time interval of exactly 0.6 second as determined by a crystal oscillator. The output indication is in the form of lighted neon lamps, one for each decimal digit. Total accuracy is roughly 1 part in 10^3. A teledeltos paper record of the output can be made on a digital basis.

Electromechanical Instruments

Calibrated Electromechanical Resonators: One of the most useful properties of these devices is their availability as miniature secondary frequency standards. Further development may be expected to improve flexibility in broadband applications.

Vibrating-Reed Frequency Meters use steel reeds, mechanically tuned to definite natural frequencies and vibrated by an electromagnetic armature. The range of frequencies covered is from 15 to 1500 CPS, or 100:1. Adjacent reeds are usually different in frequency by 0.8 to 2%. Reeds can be tuned to within 0.2% of rated frequency but are normally tuned to within 0.3%. Accuracy is specified as 0.5% at room temperature. Corrections for temperature variations can be made and are on the order of 0.08% per 10° C. The direct reading requires moderate skill, and recording must be handled photographically. Physical size is relatively small. Input impedance is low unless auxiliary amplifiers are used.

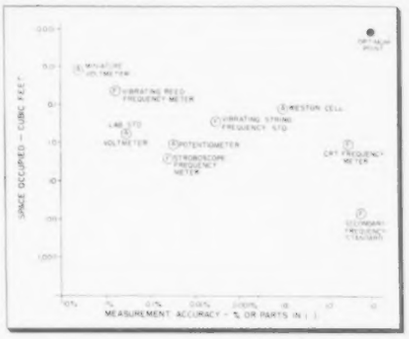


Fig. 6: Space-accuracy comparison for frequency (F) and amplitude (A) measurement systems

In Vibrating-String Frequency Meters, resonance cannot ordinarily be detected visually since the amplitude of string vibration is very small. Vibrotron units have been used in this manner—either as fixed-frequency elements sealed in vacuum envelopes to secure high Q or as instruments tunable over

(*Continued on page* 114)

Q-Meter Correction Chart for Distributed Capacitance

By ***RAYMOND LAFFERTY***
National Broadcasting Co.
RCA Building, Radio City,
New York, N.Y.

THE Q-meter measurement of inductance and Q of coils that have distributed capacitance results in a measured inductance that is greater than the true inductance and a measured Q that is less than the true Q. The measured values of inductance and Q are apparent values designated as L_a and Q_a. The true constants of the coil are known as L_o and Q_o.

A simple chart has been developed that yields the ratio of L_o/L_a and Q_a/Q_o. Ratios of 1.0 to 0.65 are shown plotted against Q-meter capacitance for values of distributed capacitance from 0.5 μμf to 20 μμf. When L_o/L_a or Q_a/Q_o is less than 0.65, the distributed capacitance can not be assumed to be lumped across the terminals of the coil, and the equation on which this chart is based is not valid.

Example: A certain inductor resonates with 45 μμf of tuning capacitance and its apparent inductance is calculated to be 30 μh. The measured Q of the coil, Q_a, equals 198. The distributed capacitance (see Boonton Radio Corp. instruction book for 160A Q-meter) of the coil is found to be 5.0 μμf. From the chart we find the correction factor is 0.9. Thus the true inductance of the coil is,

$$L_o = 0.9 \times 30\ \mu h = 27\ \mu h$$

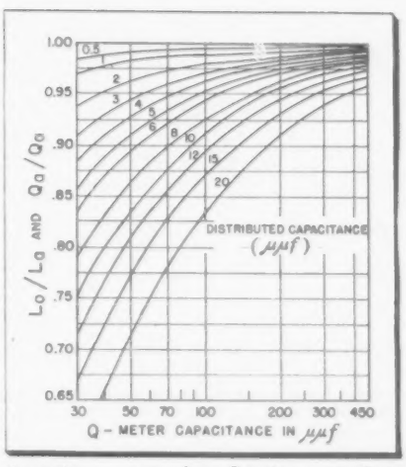
and the true Q equals,

$$Q_o = 198/0.9 = 220$$

Chart Functions

Although one function of this chart is to provide correction factors for distributed capacitance error, another is to inform and remind the engineer of the magnitude of error that exists when small values of tuning capacitance are used. Unless a specific frequency is required for the measurement of a coil, it is evident, from an examination of the chart, that for minimum distributed capacitance error, measuring frequencies should be selected that allow the coil to resonate with large values of Q-meter tuning capacitance.

It should be mentioned that this chart corrects only for distributed capacitance error. At high frequencies the measured inductance is increased and the Q lowered by the internal series impedance of the Q circuit, while the input resistance of the Q voltmeter may reduce the measured Q at both very low and very high frequencies. A "Q-meter Correction Chart for Q Voltmeter Loading" is presented by the author in the Oct. 1952 issue of TELE-TECH.



Correction curves for Q-meter capacitance

Coupling Toroidal Coils

More widespread use of concentrated field coils has shown need for a simple method of coupling two or more coils together with precise, small coefficients of coupling

By R. R. DARDEN, Jr.
Raytheon Manufacturing Co.
P. O. Box 949, Oxnard, Calif.

In the design of today's electronic equipment more and more attention is being focused on the use of small size components. To this end, in many cases, toroidal coils are finding widespread use. They present many advantages in regard to size and electrical efficiency. It is perhaps unnecessary to recall that small size, high Q, and restricted fields requiring a minimum of shielding are the obvious advantages of this coil construction. These advantages are particularly evident in that part of the frequency spectrum where previous designs required large, heavy coils with very great care in regard to shielding. It is entirely possible with toroids to mount two such coils in close proximity with no shield between them and have negligible interaction.

But in spite of their widespread use, they are used very infrequently in the type of circuit where less than maximum possible coupling is required. It is common practice to use this type of construction where, as nearly as possible, unity coupling is desired. However, for such applications as i-f transformers and FM discriminators, where coupling in the order of critical is sought, this type of construction has found very little use. It is the purpose of this paper to present a method of obtaining such small values of coupling very precisely.

Coil Mutual Inductance

If we consider two coils coupled together, we may represent them as in Fig. 1. Here L_1 represents one coil having an internal resistance of R_1, and L_2 represents a second coil having an internal resistance of R_2. The mutual inductance between them is M and the leakage inductance of the first coil is L_1-M and the leakage inductance of the second coil is L_2-M. This is according to well-established transformer theory. For each, the inductance, with the other coil open, is L_1 or L_2, respectively. Our problem with toroids is that of making M small and precisely determined. Normally, if we use one core and wind two coils upon it we find that the coefficient of coupling with present-day core materials is in the order of 0.95; while in many cases, depending on other circuit parameters, the desired coefficient of coupling may be in the order of 0.01 to 0.1.

Common Core

Suppose we try to construct this configuration with toroids directly as in Fig. 2. L_1 and L_3 in this figure are two coils wound on a common toroidal core. L_2-L_3 is another coil wound on an entirely separate toroidal core. R_1 is the resistance of L_1 and R_2 is the resistance of the two coils L_2-L_3 and L_3 connected in series. L_1 will be made to have the inductance desired in L_1 of Fig. 1 and L_2 and L_3 together will have the inductance of L_2 in Fig. 1. The effective mutual inductance between L_1 and L_2 in Fig. 2 is M, which is the same value as M in Fig. 1, and the coefficient of coupling between L_1 and L_2 is, by definition, the quotient of M divided by the geometric mean of L_1 and L_2. If K_1 in Fig. 2 is the actual coefficient of coupling obtained between L_1 and L_3, resulting in a mutual inductance between these two coils of M_1, then we have the following:

$$M = M_1 \quad [1]$$

$$K\sqrt{L_1 L_2} = K_1\sqrt{L_1 L_3} \quad [2]$$

$$\sqrt{L_1 L_3}/\sqrt{L_1 L_2} = K/K_1 \quad [3]$$

$$\sqrt{L_3 / L_2} = K/K_1 \quad [4]$$

$$L_3 / L_2 = (K/K_1)^2 \quad [5]$$

$$L_3 = (K/K_1)^2 L_2 \quad [6]$$

$$L_2\text{-}L_3 = [1-(K/K_1)^2]\ L_2 \quad [7]$$

In practice, to obtain any desired value of coupling, Eqs. (6) and (7) give the values of inductance required, providing the actual coefficient of coupling which can be obtained is known. For a particular

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First in a Series of Articles
Selected by TELE-TECH
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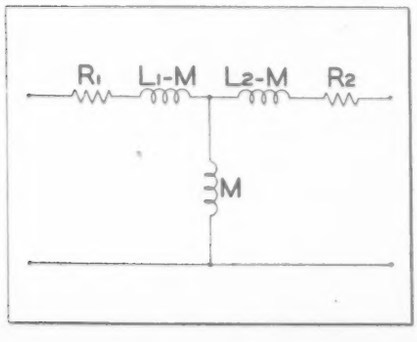
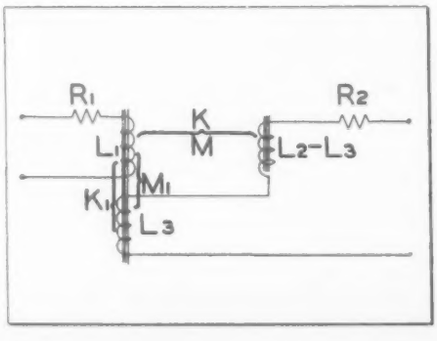
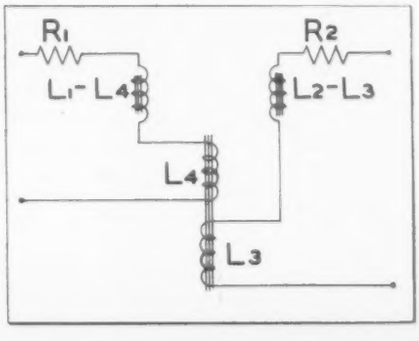
1952 National Electronics Conference
Chicago, Sept. 29-Oct. 1.

Figs. 1-3: (Left to right) Diagrams showing inductance-resistance conditions for two toroids in different circuit arrangements







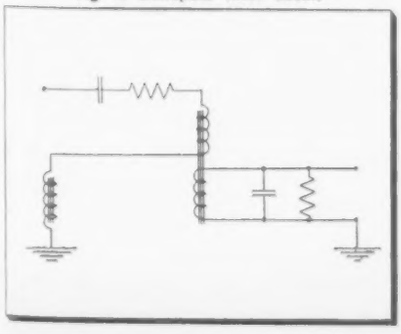
core the coil manufacturer can usually furnish this information and, of course, it is quite easy to determine experimentally. The design of the inductors themselves is usually a fairly simple problem for the coil manufacturer. In many cases, L_1 is a coil consisting of, perhaps, 200 turns. L_3 may be a single turn or, perhaps, three or four turns wound on top of L_1, and L_2 will be a coil of, perhaps, 200 turns. Such a combination may give, for example, an i-f transformer with dimensions of approximately ¾-in. cube. An FM discriminator transformer has been made using three toroids with two loops wound on one and connected in series with each of two other coils. It should be quite apparent that this method of coupling coils can be extended to any number of toroids coupled together, and is equally applicable to other types of construction, such as completely-enclosing core Universal-wound coils, coils with hypersil cores, and even coils wound upon standard E and I laminations.

Interchange of Coils

It should be equally apparent that, in a particular case, it may be necessary for L_1 of Fig. 2 to be the primary and L_2 of Fig. 2 the secondary or vice-versa, depending on the number of turns required in each of the two coils. If, in any particular case, L_2-L_3 should be found to be negative, it would indicate that L_1 and L_2 should be interchanged in their uses. In general, L_2 should be made to have the larger value of inductance, if there is a difference. In some cases, it may be desirable to use the configuration of Fig. 3. Probably this would be required only when extremely small values of coefficient of coupling are desired. In such cases, a change of one turn in L_3 of Fig. 2 can result in too great a change in mutual inductance.

The arrangement of Fig 3 gives a smaller value of mutual inductance per turn, so that these smaller values can be obtained more precisely. Furthermore, the core on which L_3 and L_4 are wound can be different from the other two, so that still greater flexibility of design is obtained. The mathematical treatment of more complex cases follows that of the simpler case given above. In particular, the ratio of L_3 to L_2 and L_4 to L_1 in Fig. 3 can each be made equal to the ratio of K to K_1, rather than the square of the ratio of K to K_1, as was true with the arrangement of Fig. 2. Or, one of these ratios, say L_3 to L_2, might be made equal to the three-halves power of the ratio of K to K_1, and the other to the square root of the ratio of K to K_1. This would result in very small increments in mutual inductance for changes of one turn in L_3, so that the value of mutual inductance can be quite precisely predetermined.

Fig 4: Bandpass filter circuit



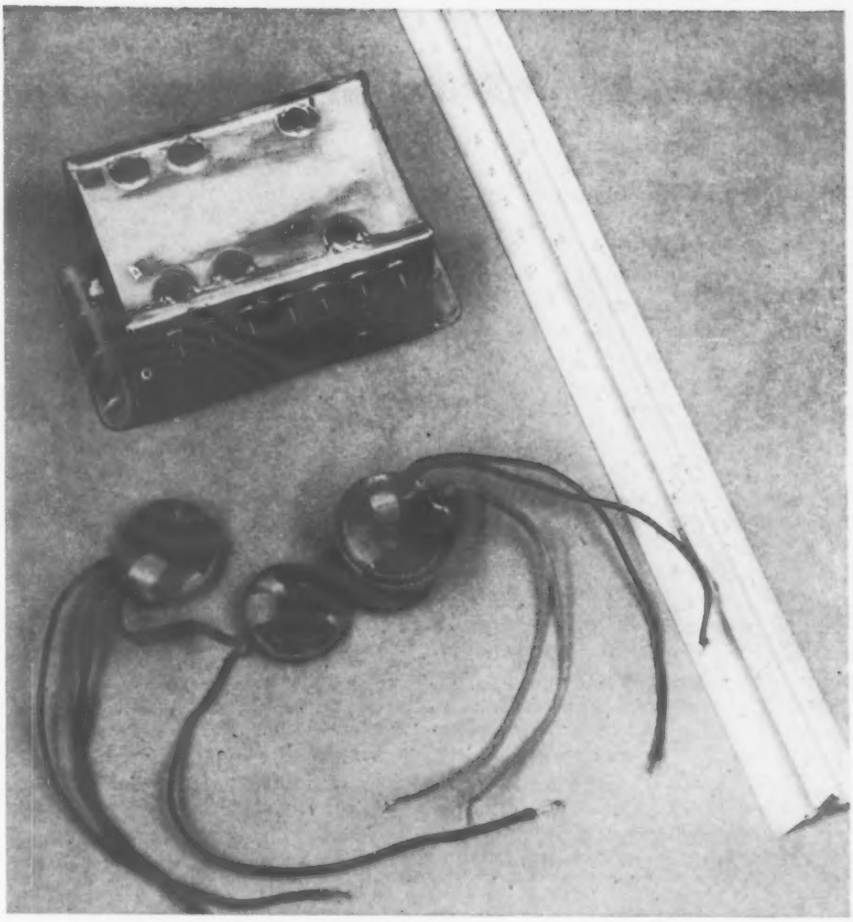


Fig. 5: Photo of bandpass filter (Fig. 4) showing various stages of construction

Coupling Loop on Core

Fig. 4 is the circuit of a bandpass filter using this construction. Fig. 5 is a photograph of such a filter showing various stages of construction. The coupling loop in this particular case was wound on the core by the coil manufacturer when the coil was first made. The two coils, after all connections are made, are potted, using a thermosetting polyester resin. The canned unit contains three such assemblies with their associated capacitors and resistors. All the frequencies in this particular unit are in the audio region of the frequency spectrum.

Conclusions

The described method of coupling is very simple and precise. That it would give the desired results seems obvious, now that it has been in use for a period of time, but it does not seem to be generally known. This has been used with toroids in building i-f transformers, FM discriminators, bandpass filters, and other filter elements in the audio, supersonic and radio frequency portion of the spectrum up to about 2 MC. It has also been used with completely-enclosing core Universal-wound coils, where slug tuning was desired. In every case, greater uniformity of electrical characteristics has resulted during production runs. In one particular instance, previous design had used an iris between two coils which were completely enclosed otherwise. Rejections were very high. Since this method of coupling has been adopted, rejections are almost unheard of.

Voice Frequency Tone

Reliable system uses feedback-type selective circuits triggering in 300-3000 cps range eliminated by

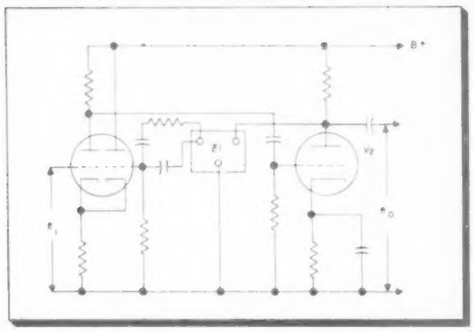


Fig. 1: Feedback-type selective amplifier limits tone frequency range to 300-3000 CPS

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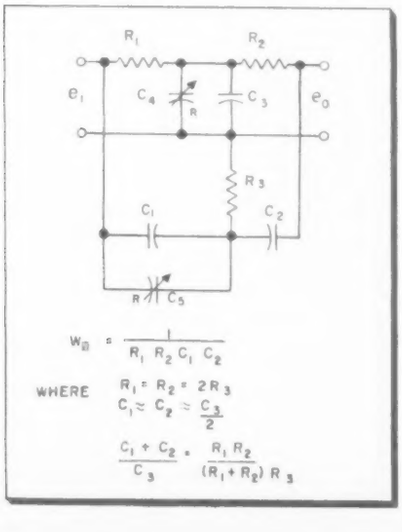
IN the radio communication field, the need for selective signaling devices has been recognized for the past several years, and many devices have been developed to satisfy the need. The devices which are described in this paper are the result of market analysis, experiment. and extensive field testing to make a system of voice-frequency, tone-signaling apparatus which substantially fills the need.

All such developments traverse a similar path, horse-sense analysis plus empirical ideas, through controlled experiment followed by formulation of a theory. When the process is repeated often enough, theoretical details are corroborated by experiment. The essential characteristics for a signaling system to be applied to radio communications systems were so developed.

1. The signals must be transmitted equally well over wire-line telephone-exchange facilities and r-f transmission paths.

Fig. 2: Network representation of amplifier



2. The signal should consist of audio tones in which only the frequency is used as a distinguishing characteristic.
3. The tone frequencies used must lie within the voice-frequency range 300-3000 CPS, in order to be usable over normal telephone circuits and to comply with International Radio regulations.
4. Because of the vagaries of r-f propagation, the signal should be completed in less than 0.5 second to insure reliable operation.
5. Since the tone signals must be in the voice band, there is a finite probability of simulation of the tone signals by voice. "Voice triggering" must be minimized by highly selective circuits and time-constants of the proper magnitude to comply with (4). Experimentally, it has been found that a circuit "Q" of approximately 200 and an integration time of the order of 0.1 second reduce the probability of "voice-triggering" to negligible values.
6. The intermodulation distortion of typical communication systems is very high so that the use of simultaneous tones should be avoided. The intermodulation process readily creates sum and difference frequencies which thereby generate false signals. When the investigation began this was only a subjective impression, later confirmed by measurements on typical systems. As a consequence, single or sequential tones should be used for selection.
7. Communication receivers of different manufacture tend to considerable uniformity at the output of the audio detector so the signal should be derived from this point. A further advantage of this point of "take-off" is the independence of volume control and squelch settings which would otherwise influence performance in a highly variable manner.
8. The coding system must be simple and direct; random codes must be avoided. This requires considerable elaboration and will be discussed when the selective calling system is described.
9. The devices should be as nearly all-electronic as possible.
10. The devices must function in the environments to which mobile communication systems are subjected.

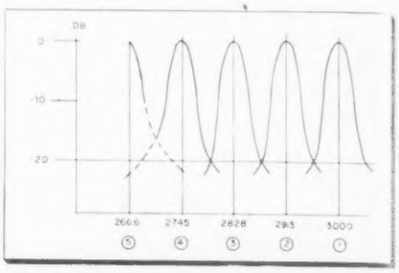


Fig. 3: Tone spectrum with 3% separation

Basic Elements

Selective Amplifier: The limitation of tone frequencies to the band 300-3000 CPS poses a difficult selective amplifier problem. For a solution there are several approaches, each of which have been described in the literature. It was finally decided to develop a feedback type selective amplifier, i.e., a linear amplifier employing frequency selective negative feedback (a parallel-T network).

From the literature reasonably useful theoretical analyses were obtained. For a very low-Q circuit the analyses were adequate, but for high-Q application considerable additional analytical work was necessary. As a feedback amplifier, the stability problem was complicated by the fact that a parallel-T network is not minimum-phase and the usual Nyquist criteria do not apply. The stability margins of the amplifier which has been developed are more than adequate to insure reliable operation under all conditions.

In Fig. 1, the selective amplifier is shown schematically. The A-circuit consists of $V1_a$ and $V2_a$, the β-circuit consists of Z_1 and $V1b_1$ with associated coupling networks. At resonance f_0, Z_1 attenuates 90 db or more, so the full forward gain (approximately 60 db) is attained from $V1_a$ grid to $V2_a$ plate. The Q of the selective circuit thus formed is approximately 200. The double-triode circuit is chosen for simplicity and

Signaling for Mobile Radio Systems

...o signal mobile stations singly or by group. Voice ...using Q of 200, and integration time of 0.1 second

...elative stability against changes in ...gain to filament and B+ voltage. ...This selective amplifier functions ...very satisfactorily over B+ varia...tions of 100- 300 v. and filament ...variations 4-8 v. ac or dc.

Overall Performance

It is, of course, obvious that the overall performance of the entire device is proportional to the stability of Z_1. Z_1 is actually a slightly modified parallel-T network which is the result of the major part of the development effort. A large amount of painstaking trial and error plus analytical investigation may be summarized as follows (see Fig. 2):

1. The physical configuration of the assembly is extremely important. Shields and grounds must be properly located to minimize capacity from input to output of the network.
2. Even though there is an apparent gain in selectivity achieved by making the output impedance much greater than the input impedance, the most economical and efficient design is actually obtained by making the impedance equal.
3. The resistances must be wirewound, stabilized types, of as low a value as is consistent with the loading imposed on the circuit. The lower values of R minimize capacity troubles and make possible an unloaded termination.
4. The thermal stability is a function of the ratios $(C_1 + C_2)/C_3$ and $(R_1R_2)/(R_1 + R_2)R_3$. If the thermal coefficients of these ratios are balanced, the device will be stable. The range of variation of the individual coefficients is most important, so the only recourse is to statistical analysis. For the networks we have built to date the net coefficient is normally much less than the 15 ppm/°C maximum.
5. Each network must be tuned to a null which must exceed 90 db at f_0. We have consistently obtained stable 120 db nulls in factory test.

Stable Selective Amplifier

Stable selective amplifiers of the type described have been built to Q's as high as 700 and over the frequency range 300-20,000 CPS. For voice frequency tone signaling we have restricted the frequency range to 300-3000 CPS and have chosen a Q of 200. This choice of Q is determined by several considerations:

1. The rise time, $1/\pi\Delta f$, should be less than 0.1 second at the lowest tone frequency in use.
2. Within the audio band, the lowest value of Q consistent with reliable operation free of "voice triggering" has been experimentally determined to be approximately 200.
3. Experimentally, it has been found that 20 db rejection of the adjacent tone frequency is satisfactory.

These factors, plus the temperature drift consideration, establish a spacing of 3% as the most economical of frequency spectrum. The individual tone frequencies are obtained by using 3000 CPS as a base and counting downward. See Fig. 3.

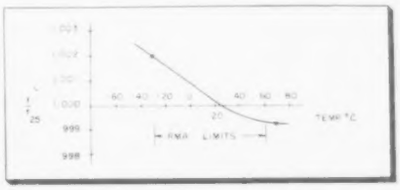
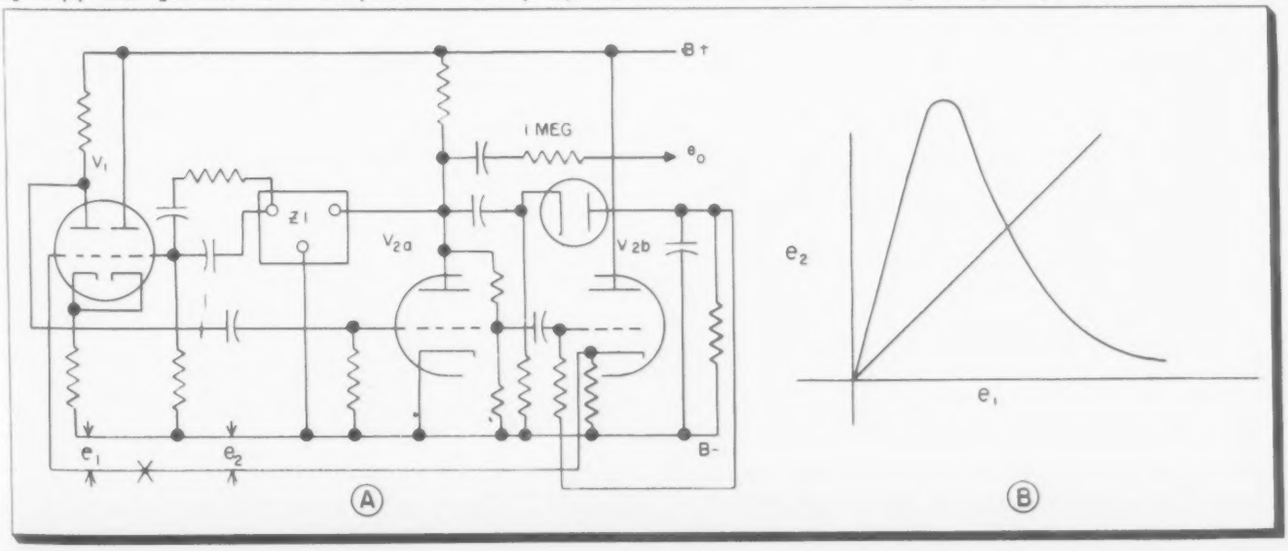


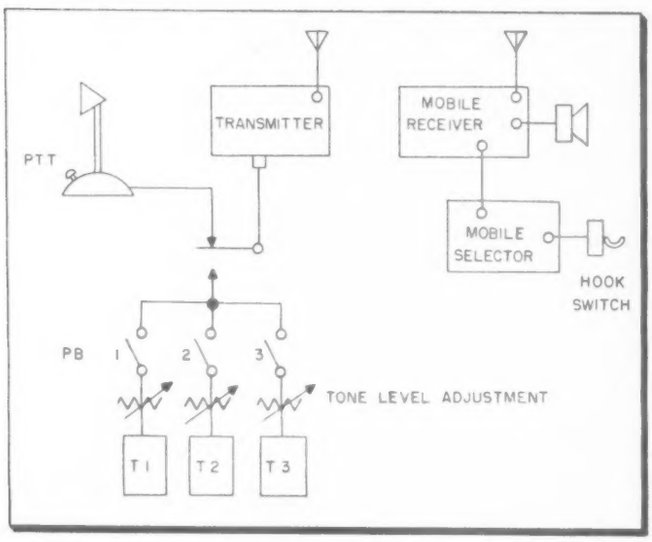
Fig. 5: Generator frequency-temperature curve

A stable selective amplifier is of little use unless the tone source is of equal or greater stability, particularly since it is necessary to assign a major portion of the system degradation to the devices employed in the mobile equipment.

Two kinds of errors arise in a frequency selective system—absolute and relative differences between the frequency generated and the frequency to which the selective amp-

Fig. 4: (a) Tone generator circuit incorporates same frequency selective network as selective amplifier. (b) Negative control characteristic





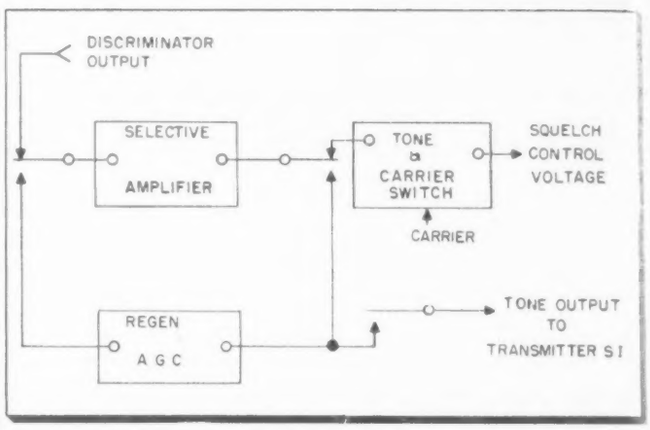


Fig. 6: (I) Selective dispatch system has only one adjustable control. Fig. 7: Duplex selector

lifier responds. The relative errors are a function of the thermal stabilities in different environments, but the absolute error may arise from entirely different considerations. If the selective circuits or the amplifiers differ then the processes of tuning, tube replacement, etc., may introduce large absolute errors.

Tone Generator

The tone generator which has been developed embodies a very satisfactory solution to the problems cited. It resembles to some extent the frequency-standard generator described by L. A. Meacham, and incorporates the fundamental ideas of Llwellyn. It is shown schematically in Fig. 4a. The salient points may be summarized as follows:

1. The amplifier, $V1_a$ and $V2_a$, operates in a linear manner. The interstage constants are essentially the same as those employed in the selective amplifier.
2. The frequency selective network is the same as used in the selective amplifier. It is operated from a voltage generator, into a cathode-follower $V1_b$, and is substantially unaffected by external circuits.
3. The regenerative feedback is controlled by an AGC circuit which yields a very satisfactory negative control characteristic. This circuit's characteristic is shown on Fig. 4b.

It will be noted that the output of the generator is a 1 meg. resistor which minimizes any effects of load impedance variation. The generator shown has proven extremely satisfactory for the purpose.

1. The absolute frequency error is negligible.
2. The frequency drift is negligible as a function of plate supply or filament supply voltage variation. In a typical instance, the frequency changed approximately 1 CPS out of 3000 when the plate supply voltage was varied from 80 to 400 v.
3. A typical variation of frequency as a function of temperature is given in Fig. 5. Since the selective amplifier is similar we have a good index of the thermal stability of the devices which incorporate these basic circuits.

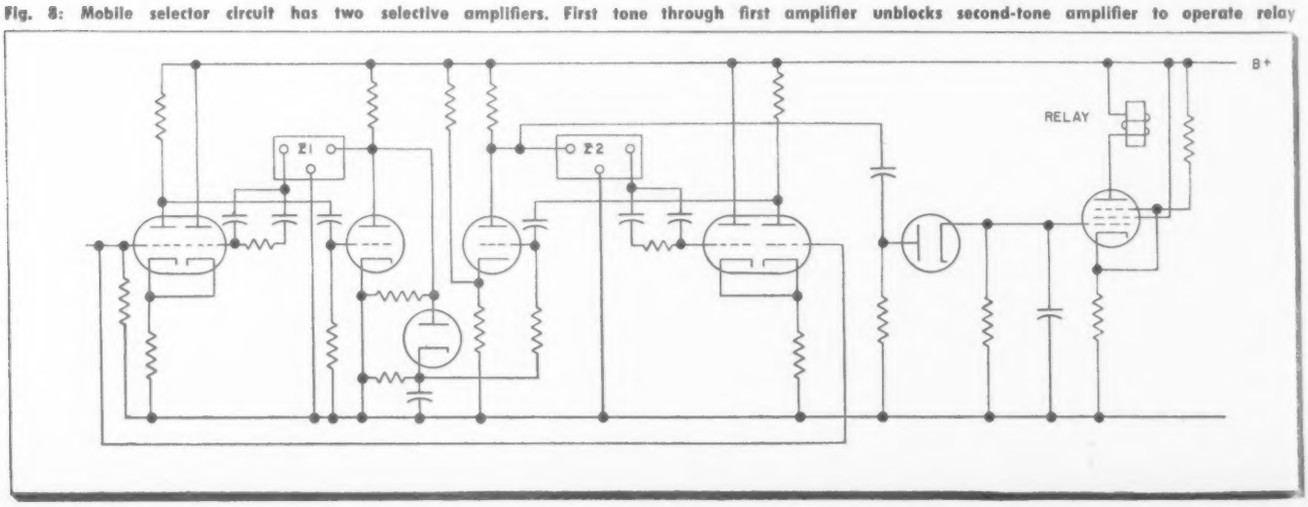
Sample Checks

In the course of testing this tone generator the agreement between theoretical and measured performance was found to be excellent. Due to the statiscal variation in components the values cited may be considered typical. Sample checks from time to time show no significant variations.

These two basic building blocks, the tone generator and selective amplifier, have been built in substantial quantities as parts of discreet pieces of equipment. To date no significant variations from pre-

(*Continued on page* 88)

Fig. 8: Mobile selector circuit has two selective amplifiers. First tone through first amplifier unblocks second-tone amplifier to operate relay



High-Efficiency Coolers for Power Tubes

Heat transfer coefficient for transmitting tubes doubled with discontinuous fin structure in forced-air systems. New design prevents solder voids

By M. B. LEMESHKA & A. G. NEKUT
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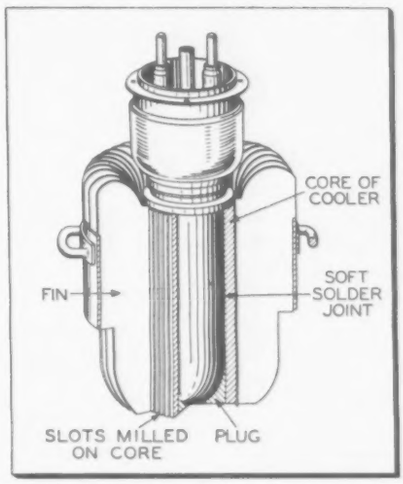


Fig. 1: Basic cooler design comprises thick-walled copper core, plug, and radial fin array

UNTIL recently there had been no significant change in the design of electron-tube coolers since their introduction in 1936. Now, however, a new design has been developed which reduces substantially both the weight and the air-flow requirements of coolers.

Because a portion of the power supplied to an electron tube is dissipated in the tube as heat, tube ratings are established which limit the temperature rise of the tube elements to a safe operating value. Forced cooling makes it possible to increase tube ratings beyond the values which would necessarily be assigned if natural cooling only were used. In addition, forced cooling permits a reduction in tube size, an important feature in the design of high-frequency tubes, even those having only moderate heat-dissipation requirements.

Additional Power

When forced or artificial cooling is employed, however, additional equipment and power are required. Equipment for forced-air cooling of the anode (where most of the power is dissipated) consists of (1) a metal-to-air heat exchanger (the cooler) and (2) the blower with its power source and appropriate ductwork. The main disadvantage of the conventional cooler is that its weight is usually many times that of the tube. Coolers for large power tubes may weigh up to 200 pounds. The conventional blower also may be large and bulky compared to other components of the installation, and its initial cost usually is considerable. It is advantageous, therefore, to reduce the required size of coolers and blowers as much as possible.

The basic design of most coolers now in use is illustrated in Fig. 1. The cooler consists of a thick-walled copper core, a copper plug, and a radial array of plane copper fins. The fins are fitted into longitudinal slots milled into the copper core and the parts are joined by means of silver-alloy brazing. The cooler is soldered to the copper anode of the tube after all assembly and exhaust operations have been completed on the tube structure. A soft solder, having a melting point of approximately 300 degrees Centigrade, is used because the high temperatures necessary for silver-alloy brazing would destroy the finished tube. It usually is not feasible to join the fins directly to the copper anodes of the larger tubes because of manufacturing considerations. In operation, air is forced between the fins of the cooler in a direction parallel to the core.

Cooler Design Factors

In seeking to reduce the air-flow requirements and the weight of coolers, the designer must take into account the following expression which gives the rate of heat loss from fin surfaces to an adjacent air stream:

$$q = h_c A \Delta t_m$$

where q = rate of heat loss from surface area of cooler in British thermal units per hour; h_c = film coefficient of heat transfer in British thermal units per hour per square foot per degree Fahrenheit; A = surface area of cooler in square feet.

Δt_m = mean temperature difference between the cooler surface and the air in degrees Fahrenheit.

For a given tube type, the rate of heat loss, q, is equal to the plate dissipation rating plus a fraction of the filament-power input and a fraction of the grid-dissipation power.

The mean temperature difference, Δt_m, depends upon the temperature of the incoming air and the maximum anode temperature rating of the tube. Because Δt_m is a *mean* temperature difference, it is determined not only by the rise in temperature of the air passing through the cooler, but also

Fig. 2: Discontinuous fin has edges of rib sections normal to air flow, increasing heat transfer

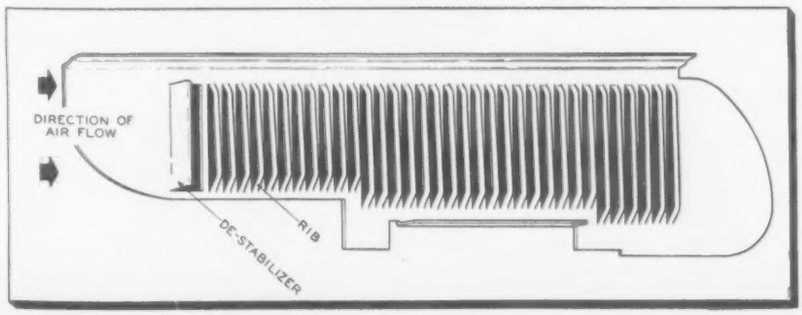
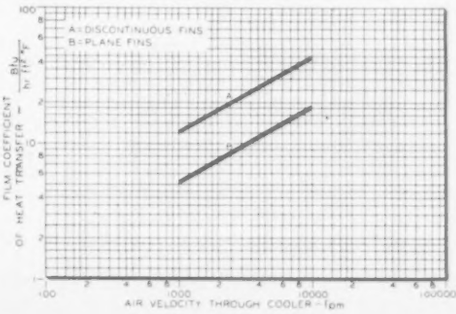


Fig. 3: Velocity-heat transfer characteristic



by the axial and radial temperature drops in the cooler core and fins. Methods for computing these temperature distributions have been published.[1] The maximum anode temperature rating of the tube is limited by the melting point of the solder used to join the anode to the cooler and also by the safe operating temperature of the anode with respect to gas evolution. It is evident, therefore, that the value of Δt_m cannot be increased arbitrarily by any large amount.

Heat Transfer

Any appreciable improvement in cooler performance or reduction in cooler weight, therefore, must be obtained by making changes in the film coefficient of heat transfer, h_c, and the surface area, A. It is usually possible to make appreciable gains in cooler performance by increasing the number of fins and decreasing their thickness, thus increasing A, the surface area. The usefulness of this approach is limited, however, by considerations of mechanical strength, especially in large-size coolers, by decreasing fin efficiency due to temperature drop along the fin, and by considerations of air-flow and pressure-drop.

Discontinuous Fins

Attempts to increase the film coefficient of heat transfer, h_c, by increasing the air velocity were not considered practical because the air pressure required across a cooler increases at least sixfold if the air velocity is to be raised sufficiently to double h_c. However, the use of another approach to the problem of increasing h_c which was described some years ago[2], led to the adaptation of a discontinuous fin structure for use in power-tube coolers.

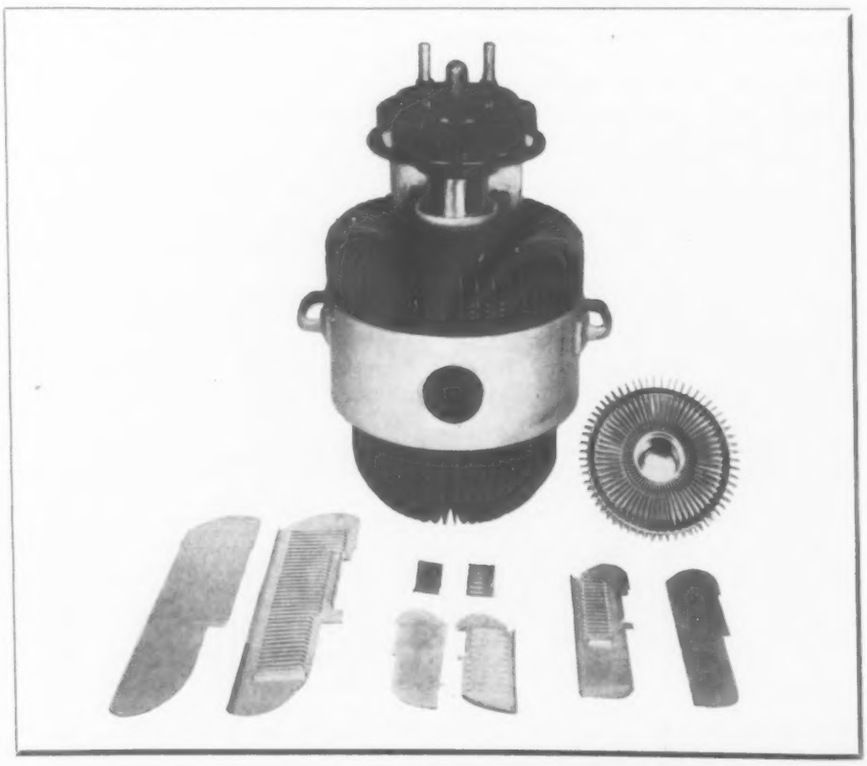
Fig. 2 shows one form of the discontinuous fin with its ribbed structure. This discontinuous fin is made with a multiple punch-and-die set which divides a plane fin into a number of short sections, the leading and trailing edges of which will be normal to the direction of air flow. The width of the rib in the direction of air flow is generally made as small as possible. As can be seen from Fig. 3, for a given air velocity the film coefficient of heat transfer, h_c, for the new fin design is approximately twice that for the conventional plane fin. The significance of this increase in h_c can be noted from a comparison of the measurements made on two coolers. Both coolers were similar to that used on the RCA-5762 tube shown in Fig. 4 and the two were identical in size, weight, and number and thickness of fins. In both cases, 2.7 kw were dissipated in the anode as heat, and the amounts of air flow were adjusted so that the two anodes operated at the same temperature. As can be seen from the measurements given in Table 1, the conventional plane fin cooler requires an air flow of 275 cubic feet per minute and the static pressure required to force this flow through the cooler is 1.81 inches water gauge. The new cooler employing discontinuous fins requires an air flow of only 130 cubic feet per minute, less than half the amount used in the conventional cooler, and the static pressure drop is 0.61 inches water gauge, approximately one-third that required for the conventional cooler. The product of air flow and static pressure, called the theoretical blower horse-power coefficient, is a criterion for comparing performance. It can be seen that the cooler employing discontinuous fins requires only 16 per cent of the theoretical blower horse-power needed for the plane-fin cooler. This reduced air requirement permits a reduction in size and cost of the blower required, and also makes quieter operation possible. In the case of the RCA-5762, weight reduction is relatively unimportant, because cooler weight is only 3-½ pounds; the advantage of the new fin design lies entirely in improved performance.

Weight Reduction

In other cases, however, it is desirable to increase h_c to obtain maximum weight reduction. Table II gives a comparison of the weights of both types of coolers for two tube types showing the reduction in weight ob-

Fig.4: RCA-5762 Power tube and cooler

Fig. 5: Fin structure of several new cooler designs, including those listed in Table II



tained when the discontinuous-fin structure is used. Temperature and air-flow ratings remain the same for old and new coolers in this case. Several new cooler designs, including those listed in Table II, are shown in Fig. 5.

Theory of Operation

Some explanation can be given for the improved performance of the discontinuous fin compared with the conventional plane fin. Although the rate of heat transfer by forced convection between a solid and a fluid depends on many properties of the fluid, it is primarily a function of the thickness of a slow-moving layer of fluid immediately adjacent to the surface of the solid. For a given metal-air system and fixed air velocity, h_c is determined by this air-film thickness. A fin design which reduces this thickness makes possible an increase in performance and efficiency and a decrease in cooler weight. Fig. 6 shows the distribution of heat flow per unit area about a heated pipe of circular cross-section when placed in a unidirectional air stream. As can be seen, film conditions at the trailing and leading surfaces of the pipe are such that the heat flow is at a maximum there; heat flow from the sides

TABLE I

PERFORMANCE OF SIMILAR COOLERS WITH DIFFERENT FIN STRUCTURES

Fin Structure	Air Flow cfm	Static Pressure in. of water	Blower Horse-Power Coefficient*
Plane	275	1.81	498
Discontinuous	130	0.61	79.4

Coolers: Similar to that on RCA-5762 except for fin structure.
Power Dissipation: 2.7 kw
Anode Temperature: 160 °C
* Air Flow X Static Pressure

is at a minimum. It may be postulated that analagous results are obtained with individual ribs of the discontinuous fin. Therefore, the leading and trailing surfaces of a pipe, bar, or fin are the most efficient heat-transfer surfaces. In the high-efficiency fin, the trailing and leading surfaces have been increased to a maximum.

When air was passed through the first test samples of discontinuous fin coolers, a series of loud, whistle-like tones were produced. The pitch could be changed by varying the velocity of the air. The changes in pitch occurred in discrete steps and were exactly reproducible as a function of velocity. Because these whistle-like tones are objectionable, the discontinuous fin in power tube applications must be made to operate quietly. It was noted with the sample coolers that the frequency of the tones corresponded to the harmonic sequence found in an open-ended organ pipe. In this type of organ pipe, a stable system of vortices is formed between the throat edge and the origin of the air stream directed upon the edge. This stable system of vortices in the air stream provides the periodic compressional pulses which produce a sustained tone when reinforced by a pipe length harmonically related to the frequency of the pulses.

TABLE II

COOLER WEIGHT REDUCTION

Tube Type	Initial Weight lbs	Redesign Weight lbs	Weight Saving lbs
RCA-889R-A	31.5	19.8	11.7
RCA-5671	195	90	105

To eliminate the tone it is necessary to destroy the stability of the system of vortices at the edge. The space enclosed by adjoining cooler fins appeared to be analogous to the open-ended organ pipe, and tests showed that the bottom rib served the same purpose as the edge in the throat of an organ pipe. For this reason, the specially shaped tab or "destabilizer" shown in Fig. 2 was inserted in the fin just before the bottom rib. The air stream flowing by this tab becomes very turbulent and has an irregular flow pattern, making impossible the stable system required to produce sound. After the "destabilizer" was incorporated, no whistling tones could be heard at any rate of air flow.

Thermal Bond Improvements

Another improvement in the design and fabrication of coolers made during this development is a novel method of mechanical assembly and brazing which assures that all of the fin-root area is thermally bonded to the core. In the old method of construction, axial slots were milled into the core tubing, as shown in Fig. 1. Brazing alloy foil and plane blanked fins were fitted into these slots and the entire assembly was placed in a fixture, which was then inserted into a brazing oven. The temperature controls governing the quality of brazing were necessarily indirect controls and no assurance that all of the fin-root area was thermally bonded to the core could be obtained without a destructive test.

In the new coolers, the fins form a lap joint with the core and a lap-and-lock joint with adjacent fins. In one method of fabrication used, the fin-and-core assembly is mounted on a rotating horizontal spindle and is heated to brazing temperature by oxyhydrogen burners in air. Complete visual control of the temperature is possible at all times. A rod of silver brazing alloy is inserted into a chamfered joint between fins and core at one end of the cooler. The brazing alloy melts and flows horizontally through the cooler between core and fins, displacing the brazing flux which had been applied prior to heating. When the alloy has emerged at the other end of the cooler, a perfect joint exists between the core and all points of the fin-root area. This new method provides assurance of improved quality of the thermal bond between the fins and the core.

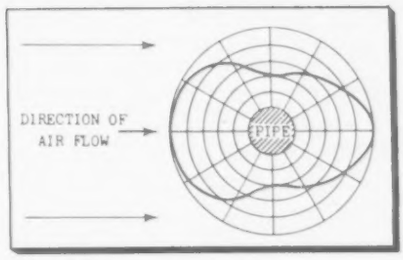


Fig. 6: Heat flow distribution in air stream

Thermal Path

The thermal path between the cooler fins and the tube anode is further improved by the addition of an excess-solder well to the core, as shown in Fig. 7b. The original core design is shown in Fig. 7a. Generally, a powertube cooler is thermally bonded to the tube anode by a solder joint. A quantity of solder is melted in the deep cup within the cooler core, the tube anode is inserted into the core, and the assembly is allowed to cool. This method has several shortcomings which seriously impair the quality of the thermal solder bond and result in excessive local anode temperatures or "hot-spots". These faults occur chiefly in the upper section of the core-to-anode joint and are caused by:

1. Voids developed during solidification of the solder.
2. Flux residue trapped in the thermally critical areas.

These sources of trouble were studied during tests in which glass tubes were substituted for cooler cores so that the flow and solidification of solder and flux could be witnessed. The voids developed as the solder solidified. They were caused by the contraction on solidification inherent in the solder (lead contracts almost

(Continued on page 112)

NEW EQUIPMENT for Designers and Engineers

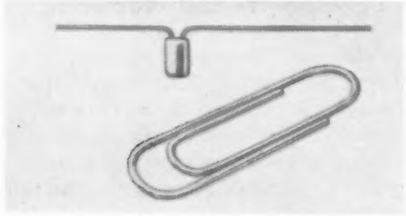
Ruggedized Meters

Shock mounted in a special low temperature rubber compound and bonded to the case, the meter movement is rigidly held

and does not flop around under vibration or shock in a new line of ruggedized meters. Jewels are mounted in a solid metal core and pivots are mechanically fastened on the inside of the moving coil. New type case has rear panel with screw type terminals to eliminate necessity of soldered connections. Case is permanently hermetically sealed at the factory; however, special case design and neoprene gasket permit opening and resealing of case with the use of simple tools. All internal parts, including resistors and multipliers are readily accessible.—**Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio.**—TELE-TECH

Selenium Diodes

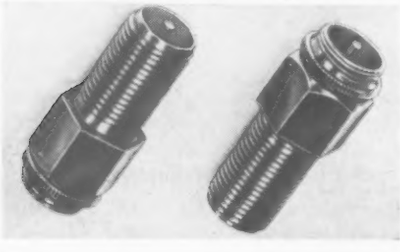
Two new selenium diodes, type 1S1 and type 5U1 augment the line of eight types currently being produced for operation in



an ambient temperature range of 50 to 100°C. The type 1S1 is rated for a maximum input of 26 v. rms at 100 μamps output while the type 5U1 is rated for 130 v. The units are completely encapsulated within a thermosetting plastic. Type 5U1 is said to be ideal for obtaining a bias voltage in the order for 100 v. or more when connected directly to the 117 v. line. The output voltages available by the use of these diodes are 20 to 100 v. at currents of 100 μamps to 1.5 ma. The selenium diodes are extremely small in size, thereby facilitating wiring them into a crowded chassis.—**International Rectifier Corp., 1521 East Grand Ave., El Segundo, Calif.**—TELE-TECH

Electromagnetic Pick-Up

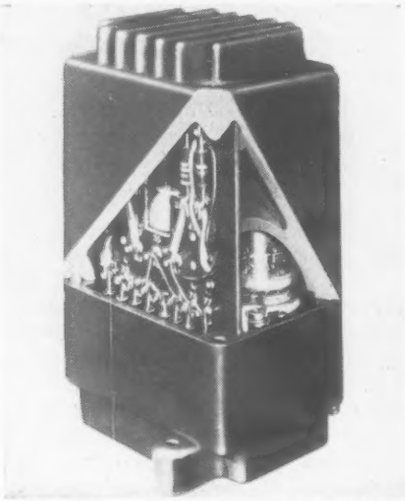
Model 3010 electromagnetic pick-up operates without physical contact when mounted near any moving magnetic material. It is an electrical impulse generating device that



produces a voltage output proportional to the rate of motion or speed of the magnetic object. It can be actuated by the keyway in a shaft, the teeth of a gear, the spokes of a wheel, a slot in the rim of a wheel or shaft, a screw head or pin on a moving part or any vibration or displacement of magnetic material in the field of the pick-up.—**Electro Products Laboratories, Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.**—TELE-TECH

Circuit Assemblies

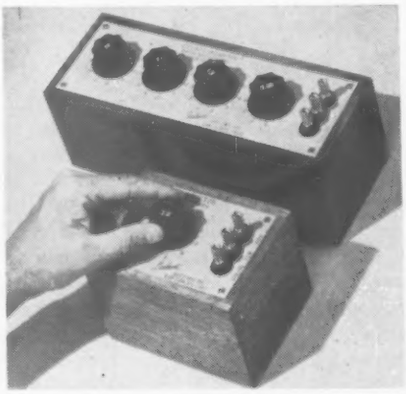
"Unistage" as a self-contained unit assembly in which 1 to 4-tube circuits may be constructed. The basic unit comprises: the die



cast aluminum housing; a terminal board having a large number of single and through terminals which are coded for easy assembly of components; the tube plate which allows the use of standard miniature and oval sockets; and the tube well or wells. Production and process engineering information is included. The manufacturer also custom-produces completed Unistage units with the specified circuitry.—**Technical Development Corp., 4036 Ince Boulevard, Culver City, Calif.**—TELE-TECH

Decade Inductors

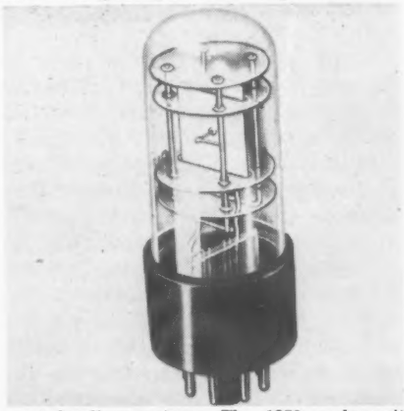
Inductance values guaranteed to within one percent are available with the new Lenkurt decade inductors. Four individual



units cover the ranges from 1 to 10 mh, 10 to 100 mh, 100 mh to 1 henry, and 1 to 10 henry. All four units are also available as a single unit to cover the complete range from 1 mh to 10 henry. Special ranges are available on request. Moisture resistant impregnated inductors are wound on molybdenum permalloy toroidal cores for high-Q and low external pickup. Each decade has complete electrostatic shielding. Full rotary switches for selecting inductance values have low contact resistance, laminated self-wiping contacts, and positive detents.—**Lenkurt Electric Co., 1116 County Road, San Carlos, Calif.**—TELE-TECH

Crystal

Typical application for the new G-9 and G-9J crystal is in establishing vertical and horizontal glide paths for airplane instru-



ment landing systems. The 1350 cycle unit can be divided by 15 and 9 to produce the 90 and 150 cycle standard frequencies. It is vacuum-sealed, wire-mounted with gold or silver plated crystal, octal base and 6V6GT envelope. The G-9 is available with frequency range from 4 KC to 300 KC; the G-9J from 1.2 KC to 10 KC.—**James Knights Co., Sandwich, Ill.**—TELE-TECH

Triode

A new low microphonic subminiature triode, designated CK6247 (formally known as CK628), has a maximum noise output of

2.5 mv ac across 10,000 ohms in the plate circuit when the tube is subjected to vibrational acceleration of 15 g at 40 cps. The normal amplification factor rating is 60, and the mutual conductance rating 2500 μmhos with maximum allowable plate voltage of 275 v.—**Raytheon Manufacturing Co., Special Tube Section, 55 Chapel St., Newton 58, Mass.**—TELE-TECH

TV Camera

A portable, completely self-contained television camera has a simplified circuit that requires a minimum of attention and main-

tenance. The camera can be operated with any standard 16 mm lens, and is fitted for mounting. No special lighting, other than a normal room light, is necessary for operation. Once set for on-the-scene viewing, remote control is simply on-off power switching. The camera is equipped with a built-in view-finder.—**Dage Electronics Corp., 69 North 2nd St., Beech Grove, Ind.**

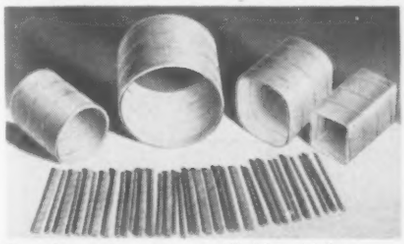
Tension Meter

A new tension meter provides protection against improper settings during coiling, winding, forming, tinning, and lacquering

operations. It is trigger operated and can be quickly inserted into the moving wire which runs over ball-bearing pulleys of the meter. The manufacture of coils and filaments of greater electrical and mechanical uniformity with greater current carrying capacity and narrower limits of tolerance is said to be facilitated through its use.—**Saxl Instrument Co., Harvard, Mass.**—TELE-TECH

Paper Tubing

Square, rectangular and radiused paper tubes ranging in size up to 9 in. on either side and round tubes up to 9-in. inner



diameter are now available. Tubes are spirally-wound of dielectric kraft, fish paper, cellulose acetate or combinations to lengths as specified. Since they are produced on adjustable mandrils, any size from fractional-inch to maximum dimensions can be furnished without extra tooling charge. Acetate overwrap on kraft and fish paper tubes, varnish dip, or resinite impregnation can be had for special applications where increased dielectric properties and unusually high resistance to moisture and corrosion are essential.—**Precision Paper Tube Co., 2035 W. Charleston St., Chicago 47, Ill.**—TELE-TECH

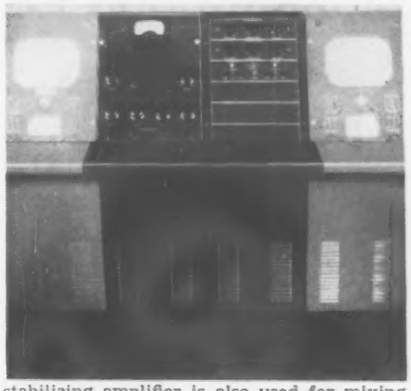
Transmitting Tube

The third in a series of ceramic-and-metal envelope power transmitting tubes is rated at 660 watts power output as r-f amplifier

in class B television transmission service and 1,100 watts in class C telegraphy service. Unlike its predecessors, types GL-6019 and GL-6183 designed for UHF operation, the GL-6017 is a VHF tube. Forced air cooled and incorporating three electrodes, the GL-6017 can be used for grounded-grid operation. It may be operated in radio and other communications in class C grounded-grid service as a radio amplifier or oscillator. In television applications, it is particularly useful for operation in the 9 to 13 channel range (174-216 MC) but is rated for full output to 400 MC.—**General Electric Co., Syracuse, N. Y.**—TELE-TECH

TV Console

A two-section TV console (TC-4A) will provide centralized audio and video control and monitoring facilities. The left-hand audio-video section of the console contains the program switching controls, composed of one row of key switches for audio control, one row of pushbuttons for video control, a video clipfader control, and a tie switch which permits simultaneous audio-video switching from the video pushbuttons. This combined switching is accomplished by using relays and provides for eight inputs of audio and eight of video, with one output for each. The audio portion of the console provides for selecting among eight inputs, such as turntable, projector, studio, remote, or network, for transmission. The right-hand console houses all the remote controls necessary for basic programming. The two top panels control stabilizing amplifiers. One of these amplifiers is for network or remote signals, and the second is for controlling any signal to the transmitter. This second



stabilizing amplifier is also used for mixing sync and video signals. The third panel controls the film projectors and slide projectors. There is also room in this console section for additional control panels.—**Radio Corporation of America, RCA Victor Div., Camden, N. J.**—TELE-TECH

Crystal Test Set

The T104A crystal test is a portable, completely self-contained equipment for the field testing and selection of 1N23B matched

crystal pairs for X-band balanced mixer applications in the frequency range of 8500-9500 MC. Provision is made for testing pairs for crystal current balance, i-f impedance balance and leakage power (an indication of r-f impedance balance); the three characteristics for which test limits have been defined in the proposed JAN specification for 1N23B matched pairs. Specifically, the requirements are as follows: crystal current balance within 10% of the lower of the two readings; i-f impedance balance within 15 ohms; leakage power less than 10 %. The equipment consists of a 2K25 oscillator, a power-set attenuator, a frequency meter, a directional coupler for determining the leakage power test limit, two matched sing.e-ended mixers for measuring leakage power, a balanced test mixer and the required power supply and switching circuitry. A vacuum tube voltmeter is included for the measurement of i-f impedance. Suitable switching permits the two indicators, a 0-1 MA meter and a null indicator, to serve multiple purposes. Critical circuit constants, however, are independent of switch position.—**Microwave Associates Inc., 22 Cummington St., Boston 15, Mass.**—TELE TECH

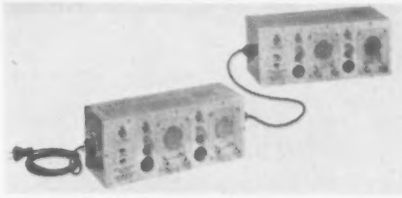
Square Wave Generator

Square waves at frequencies from 50 cps to 1 MC with a maximum rise-time of .05 micro seconds on all frequencies are

produced by type 150-A Square Wave Generator. Fixed frequencies are 50, 1,000, 10,000, 100,000, and 1,000,000 cps. Other frequencies are obtainable through the use of an external frequency-control capacitor for which terminals are provided. A pulse for oscilloscope synchronization is available. Output is controllable from 0-20 v. peak to peak and is constant at all frequency settings. Tilt and overshoot are negligible.—**New London Instrument Co., P.O. Box 189, New London, Connecticut.**—TELE-TECH

Cycling Timer

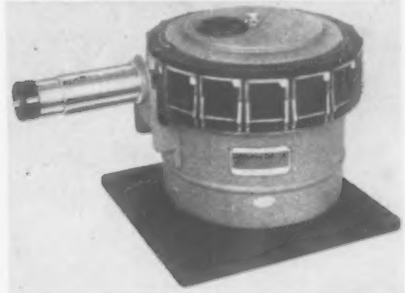
Set-up time required by the Add-A-Cycle Timer is reduced to a minimum through the use of plug-in adjustable timers, which



are supplied in six overlapping ranges, from 1.5-12 sec. to 15-120 minutes. Supplied as a basic unit with two plug-in positions, any number of timers may be cabled together and will cycle as a group, so that an unlimited number of time cycles may be obtained. Normal rating is 10 amps, 115 v., 60 cycles, but special ratings may be had upon request. For process timing the Add-A-Cycle is custom built in wall mounting cases with any required number of adjustable plug-in time cycles, which allows great flexibility and provides for easy servicing. Any cycle may be skipped without loss of time in the event any part of the process is temporarily out of use.—**Becker Equipment Co., 3020 N. Cicero Ave., Chicago 41, Ill.**—TELE-TECH

Slide Projector

A new automatic projector (TP-2A) presents either glass or cardboard-mounted slides for studio television productions. It



features a corrected, coated astigmatic 5-in. f3.5 lens to insure sharp, clear images; an indexed, rotatable turret accommodating 16 2-in. square slides which may be remotely controlled from the audio-video console; and built-in, forced-draft ventilating unit to cool the 100-watt lamp. Slides are arranged radially and detents accurately position the slides with reference to the lens. Operation of the projector is completely automatic, and the timing for each slide projected is controlled by pressing a button to rotate the turret. Approximate changing time is one second.—**RCA Victor Div., Radio Corp. of America, Camden, N. J.**—TELE-TECH

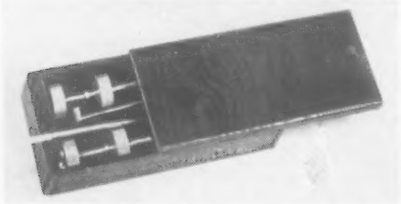
Telereader

Faster, more accurate measurements of film and oscillograph records are possible with the Universal Telereader. This unit

measures records ranging from 16 and 35mm film to 12 in. oscillograph paper up to 100 ft. long. It can handle either translucent or opaque records. Three interchangeable projection lenses are provided to permit record magnification of 2X, 4X and 11X. When used with companion instruments such as Telecomputing's Telecordex and summary punch, the Universal Telereader can print its measurements in decimal form on a typewriter supplied with the Telecordex, as well as recording such information into punched cards.—**Telecomputing Corporation, Burbank Calif.**—TELE-TECH

Setting & Locking Tools

Tools for the setting and adjustment of adapters on synchros, resolvers and servo



motors are provided in a complete kit (K-101120). Four wrenches included are: Straight Pinion—K-101150; 90° Pinion—K-101170; Socket 13 Teeth—120 D.P.—K-101130; Socket 21 Teeth—120 D.P.—K-101140—**Kinetix Instrument Co., Inc., 902 Broadway, New York 10, N. Y.**—TELE-TECH

Crystal Orientation Unit

Measurements in quartz orientation can be held to tolerances of $\pm 1_2$ minute of arc with a crystal orientation unit. An improved x-ray tube with mica beryllium windows provides excellent intensity levels and permits operation at low energy levels, assuring long tube life and low operating costs. Goniometer radius is 15 cm., (angular range is from zero to plus 90°). Scanning range is 5° on either side of any selected Bragg angle. High reproducibility is attained through use of a precision-built precision goniometer structure, highly stable power supply and measuring circuits. Settings are simplified and resetting is speeded by drop-in pins which can be utilized for angular

positions which are used most frequently. Angles can be read direct on 3 drums. Special features of the new double quartz orientation equipment include: high capacity generator suitable for 25 KvP at 6 ma (normally operated at 5 ma); fixed kilovoltage; rapid settings for diverse cuts; operation on 200-240 v., 50 or 60 cycle, single phase ac self-rectification; air-cooled generator and x-ray tube; simple and rapid tube interchange; variable milliamperage; stable count-rate meter; and new high-output, line focus x-ray tube. The goniometer has been specially designed for quartz analysis and is direct reading. The fixed divergence slit measures 0.004 in., receiving slits for BT cuts measure 0.015 in. Gearing utilizes a precision hardened worm with a spring-loaded driver. Beam shutters are mechanical and are attached to the x-ray tube housing and the scatter shield. Crystal holder is built with carboloy bearing faces held to plus or minus 0.0002 in. with respect to the center line. Geiger counter is special design proportional unit of high sensitivity.—**North American Philips Co., Inc., 750 Fulton Ave., Mount Vernon, N. Y.**—TELE-TECH

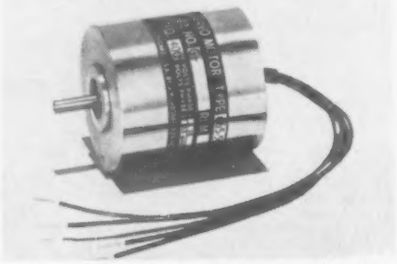
Power Tetrode

A radial-beam power tetrode (4X150D) has a heater rating of 26.5 v. at 0.57 amps. which makes it ideal for use in 28 v.

electrical systems. Size (two and one-half inches in length) and shape of the 4X150D is identical to the Eimac 4X150A and can be used with the Eimac 4X150A air-system socket. Like the 4X150A it is used as an oscillator, amplifier or frequency multiplier into UHF and has a plate dissipation rating of 150 watts in Class-C telegraphy or FM telephony service.—**Eitel-McCullough, Inc., San Bruno, Calif.**—TELE-TECH

Servo Motor

The G-M Precision motor is a small servo unit 1.7 in. in diameter and 1¾ in. long, for frequencies varying from 60 to 400



cycles, and in 2, 4 or 8 pole construction. One motor has even been supplied for 800 cycle use. Stall torque is approximately 2 in. oz., and in some instances well above that figure. Housings are stainless steel or aluminum. Output shaft can be supplied to suit, with or without integral pinion. The extreme precision required in these motors involves tolerances as small as ± 0.0001. These motors can be supplied to meet rigid military specifications with regard to humidity, temperature, range, vibration and altitude.—**G-M Laboratories Inc., 4300 North Knox Ave., Chicago 41, Ill.**—TELE-TECH

Tower

The "Fold-Over Tower" makes use of standard Rohn Tower sections and a "Fold-Over" Kit which consists of a short base

section, hinge section, boom and reel and cable mechanism. Hinges near the mid-section facilitate raising and lowering by merely turning the crank on the reel.—**Rohn Mfg. Co., 2108 Mail St., Peoria, Ill.**—TELE-TECH

Magnetic Door Latch

A new magnetic door latch will keep warped or sagging doors shut. Cabinet doors open and close easily due to an exclusive

spring action obtained by mounting the striker plate on a phosphor bronze leaf spring. Opening the door is easier because this spring tips the striker plate slightly away from the magnetic pull of the catch. The spring action also absorbs any closing impact. Even sagging or warped doors are kept firmly closed by the 3 lb. holding power of the Alnico permanent magnet. The magnet is permanently kept at the peak of its efficiency curve by means of a fixed air-gap. The device is said to last indefinitely because there are no working parts to wear out or get out of order.—**Heppner Sales Co., Round Lake, Ill.**—TELE-TECH

Microphone Control Switch

Model DFS-100 microphone control is a precision-built mechanical unit for switching an operator's headset microphone from one

communication system to another. The microphone control unit is operated by a "Micro-Switch" foot switch so that the operator's hands are free for logging or other functions. The circuit features a gang switching arrangement activated by solenoids energized by the closing of the foot switch. A load resistor is provided across the transmitting connections of the incoming circuit to prevent interruption of the connection while transmission is being made over the second communication system.—**American Radiotelephone Company, Inc., 3505 4th St. No., St. Petersburg, Fla.**—TELE-TECH

STANDARD ELECTRONIC COMPONENTS
For the past quarter of a century CINCH Components have filled the requirements developed by the rapid changes in the Electronics industry. Today, judged by demand and performance, CINCH is producing the STANDARD metal plastic assembly.
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CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

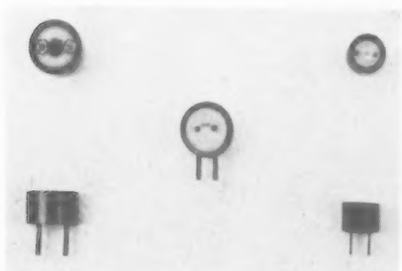
Ruggedized Meters

A new laboratory type instrument, available as a dc voltmeter, ac voltmeter and dc milliammeter, has been ruggedized for field

service. This instrument features 5 full-scale ranges, a range and scale changer which automatically changes meter electrical characteristics to correspond to the selected scale, a mirror scale for laboratory precision, 3-way binding posts, and a military type, ruggedized movement. Available singly and in sets of four, these units facilitate simultaneous measurement of 2 or more circuit characteristics.—**Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.**—TELE-TECH

Photo Tubes

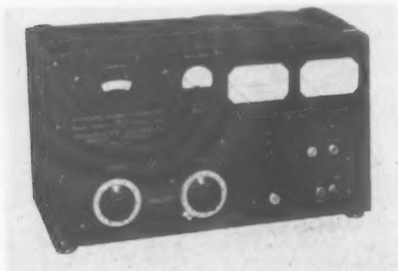
Particularly suitable for film sound pick-up and electric eye applications, two types of photo tubes are available. Lead sulphide



cell has peak spectral response at 1.5 microns, cuts off at 3.4 microns, and has time constant of 125 μsec. It has no response in the ultra-violet region. Cadmium sulphide type has peak response at 5300 A°, is sensitive to X rays, and has a time constant in the order of milliseconds. There is no response in the infra-red region in the cadmium sulphide cell. Also available are germanium junction-type power rectifiers with rms rating of 1.2 amps, 130 v. input. —**Lectro Max, Inc., 15 S. First St., Geneva, Ill.**—TELE-TECH

UHF Signal Generator

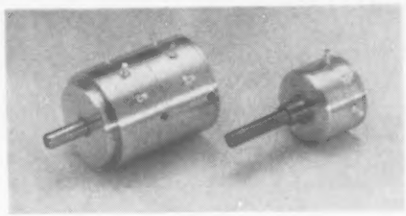
Standard signal generator, Model 84-TV, with frequency range of 300 to 1000 MC has output voltage continuously variable from 0.1μ v. to 1 v. across a 50 ohm load. The output impedance is 50 ohms and the VSWR is 1.3 to 1 or better. Provision is made for operating the filament of the oscillator tube from an external dc supply to remove residual hum. Modulation, continuously variable from 0 to 30%, may be obtained from an internal 400-cycle oscillator. Provision is also made for applying external modulation within the range of 50 to 20,000 cycles. Percentage modulation is indicated by a panel meter. Instrument is suited to



making direct gain measurements of r-f amplifiers and testing mobile communications receivers in the UHF range. It may also be used to drive slotted lines or other impedance measuring devices. Low harmonic content permits measurement of characteristics of UHF filters, traps, antennas, and matching networks.—**Measurements Corp., Boonton, N.J.**—TELE-TECH

Potentiometers

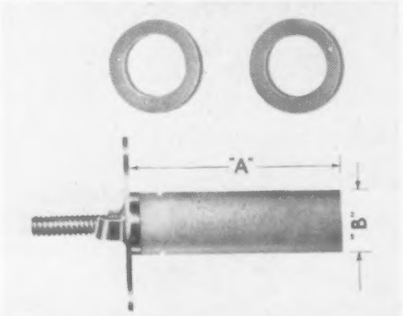
Type DS-6, ganged, $1\frac{5}{8}$ in. dia. and type RAS-2, $1\frac{1}{4}$ in. dia. are two illustrative types of custom designed precision poten-



tiometers. Both linear and non-linear pots are designed to customer's requirements. Taps and special winding angles anywhere up to 360° continuous winding can be incorporated.—**Cornell Electronics Corp., 40-22 Main Ave., Douglaston, N.Y.**—TELE-TECH

Coil Forms

Small permeability-tuned ceramic coil forms designed primarily for high frequency applications, conform to government specifi-



cations. The form itself is made of Grade L 4 ceramic (JAN. 1-10). The base is silver-plated brass while the core is brass or iron. Nylon rings are provided to separate coils if more than one is wound on the same form. Small holes in these rings can be used to secure leads.—**National Co., 61 Sherman St., Malden, Mass.**—TELE-TECH

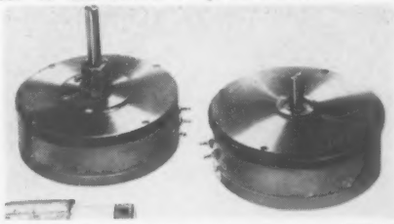
Selenium Rectifiers

A series of selenium rectifier power units has been announced that supply 115 or 230 v. dc from existing ac power lines. Starting

at 125 watts capacity, the series includes 42 standard models. Units are available for use with either 115, 230, or 440 v. 60 cycle ac. Key features are instantaneous operation, high overload capacity, and ease of installation. All units are housed in ventilated cabinets, fabricated of heavy gauge steel, and designed for wall mounting. Knockouts are provided for conduit entry, at several convenient locations. Fuses and terminal connections are readily accessible by means of hinged covers.—**Opad-Green Co., 71-24 Warren Street, New York 7, N. Y.**—TELE-TECH

Potentiometer

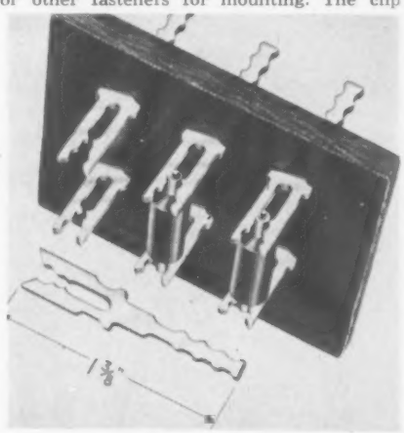
Model L/LS Series is an improved successor to the Model F potentiometer. These



new potentiometers are 3 in. in diameter instead of $3\frac{5}{16}$ in. This series is superior to the Model F in that the design is more flexible and better adapted to the use of servo lids and ball bearings. It is gangable up to eight sections and more readily phaseable at the factory. Electrical characteristics are similar to its predecessor.—**Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.**—TELE-TECH

Diode Clip

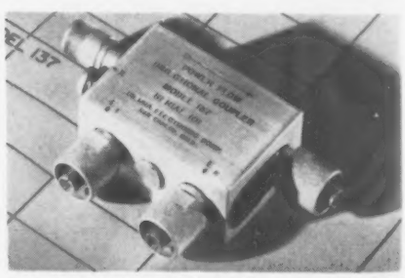
New diode clip permits easy insertion and removal of diodes. They require no rivets or other fasteners for mounting. The clip



is simply pressed into a hole on the diode board. Spring tension holds the diode securely in the clip, and a special plating assures excellent surface contact. Other advantages include greater ease in removing defective diodes, faster assembly of diode boards, and quicker initial check-out of finished equipment. They also facilitate preventive maintenance tests and the keeping of performance records on individual diodes. —**Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.**—TELE-TECH

Wideband Directional Couplers

These new wideband directional couplers are available in three models, 137 and 138 for the frequency range 30 to 1500 MC, and 139 for the frequency range 10 KC to 1 MC. Using these couplers, with suitable additional instrumentation, reflection coefficient can be determined directly, thus simplifying several important transmission-line measurements: (1) With a continuously-displayed indication of reflection coefficient, load-matching is made an extremely rapid and simple operation since the effect of adjustments can be seen immediately; (2) Load impedance can be measured in terms of characteristic line impedance and reflection coefficient with the result that any impedance can be accurately



measured; (3) Magnitude of power delivered to a specific load can be measured regardless of the length of intervening line and the degree of mismatch between line and load.—**Sierra Electronic Corp., 817 Brittan Ave., San Carlos, Calif.**—TELE-TECH

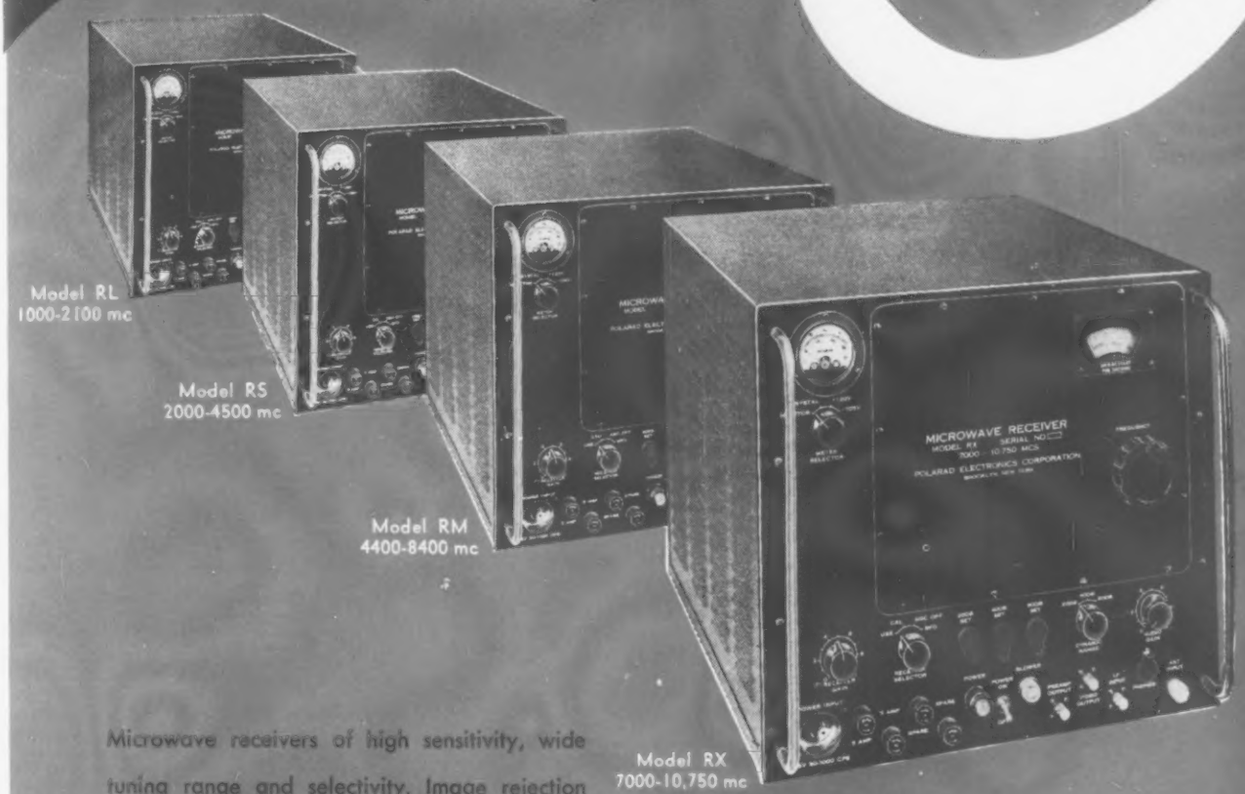
MICROWAVE RECEIVERS

WIDE BAND • HIGH SENSITIVITY

POLARAD SCORES AGAIN

The first . . . the only MICROWAVE RECEIVERS to cover wide frequency ranges.

1,000 to 10,750 mc.



Microwave receivers of high sensitivity, wide tuning range and selectivity. Image rejection is greater than 60 db. Gain stability better than ± 2 db, permits application as a field intensity meter. Extra large dials enable frequency to be clearly read to an accuracy of 2%. Video bandwidth is 3.0 mc. Input power required is 105-125 v, 50/1000 cps.

- Single Dial Tuning
- Low Noise Figure
- Tracked R.F. Preselection, Triple-Tuned
- Linear db Output Indication
- AM-FM Reception
- Video Output — 10 v Pulse across 100 ohms
- Audio — BFO
- Recorder Output
- Provisions for Using external Attenuators in I.F. Channel
- Frequency Calibration Accuracy — 2%
- Separate Audio & Video Channels
- AFC
- Calibrated Tuning Meter

Polarad
Electronics Corporation

100 METROPOLITAN AVE. • BROOKLYN 11, N. Y.
STagg 2-3464

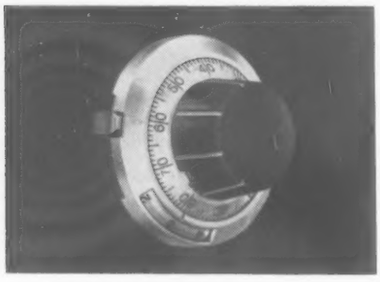
Oscillators

High stability and accurate, quickly resettable tuning circuits are features of models 200AB and 200CD oscillators. Model

200AB, for general audio tests, offers a frequency range of 20 cps to 40 KC and a full watt output. Model 200CD, for wide-range measurements at lower power levels, provides constant voltage output from 5 cps to 600 KC. Both instruments are adjusted and calibrated to meet exact frequency and performance specifications. An output amplifier provides complete isolation of the load, and changes in output load do not change oscillator performance. Frequency stability is better than ±2% including warmup, and hum voltage is less than 0.1% rated output.—**Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.**—TELE-TECH

Potentiometer Dial

Model RA Duodial gives a continuous indication of the sliding contact position in a multi-turn potentiometer. The outer



"secondary" dial, whose numerals appear in the opening, indicates which of the helical turns the slider is on. The inner (primary) dial, connected directly to the potentiometer shaft, is calibrated from 0 to 100 and indicates slider position within any given turn. No backlash error is possible in the RA because of the direct coupling of knob, dial, and shaft. This together with the fact no worm gears are employed, permits use of the Duodial with potentiometers that are driven by power devices attached to rear shaft extensions.—**Helipot Corp., South Pasadena, Calif.**—TELE-TECH

Dummy Loads

High power dummy loads which have a peak power rating equivalent to rigid waveguide accommodates power levels up to the breakdown level of the waveguide size for which they are intended. They have a built-

in metallic taper in the broad faces of the guide which provide for uniform power dissipation over the total finned area, reducing "hot" spots. Dummy loads are available with an average power dissipation equal to or greater than any existing radar system today and for the peak power rating of rigid waveguide. They are available in all waveguide sizes from 1 x ½ to 3 x 1½ in.—**Airtron, Inc., 20 E. Elizabeth Ave., Linden, N. J.**—TELE-TECH

Microwave Receivers

A series of four microwave receivers are available covering the frequency range from 100 to 10,750 MC. Triple tuned r-f preselection insures high image rejection. High order of gain stability permits application as a field intensity meter. Frequency stability permits accuracy of reading of better than 2%. Receivers include linear db indication, single dial tuning, low noise figure, AM-

FM reception, and AFC. The video bandwidth is such that a 1 μsecond undistorted pulse of 10 v. will appear across an output impedance of 100 ohms. Model RL covers the range from 1000 to 2100 MC; Model RS, 2000 to 4500 MC; Model RM, 4400 to 8400 MC; Model RX, 7000 to 10,750 MC.—**Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn, N. Y.**—TELE-TECH

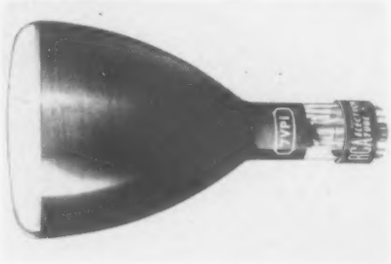
Regulated Power Supply

Newest in a standard line of electronic regulated power supply units, is the model AEC-1030, which was designed to produce a regulated 115 volt ac output at frequencies other than 60 cycle. The frequency range is 3600-4000 cycles, with other frequency ranges available on request. Frequency calibration and stability is better than 2% under normal temperature conditions. Regulations

from 0-3 amp load is ±5%. The set operates from 115 volts ac, 50-60 cycle line. The unit is assembled with standard 19 in. panels and equipped with voltmeter and ammeter. Available in either standard rack mounting or fully cased for bench use.—**American Electroneering Corp., 5029 W. Jefferson Blvd., Los Angeles 16, Calif.**—TELE-TECH

Oscillograph Tube

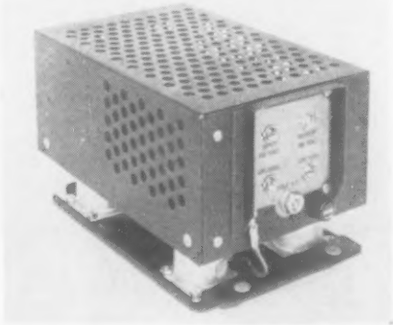
Using electrostatic focus and electrostatic deflection, the Type 7VP1 for general applications has a medium-persistence, green fluorescent screen. This tube supersedes the 7JP1, and replaces the older type where high-voltage is not more than 4000 v. Heater rating is 6.3 v., 0.6 amp. Bulb diameter is 7 in., length 14.5 in., and weighs 3 lbs. Base



is medium-shell diheptal 12-pin. Maximum voltage ratings are: accelerating, 4000 v., grid no. 3, 2000 v., grid no. 1, negative bias 200 v. and positive peak 2 v.; heater-cathode 125 v. Maximum circuit resistance values are: grid no. 1, 1.5 meg; deflecting electrode, 5.0 meg.—**Tube Dept., Radio Corporation of America, Harrison, N. J.**—TELE-TECH

Static Converter

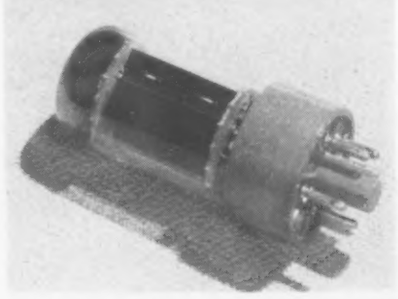
The Type E-1 static converter, 400-cycle regulated power supply will operate at altitudes up to 60,000 ft. Input voltage is 110-120 v., 380-420 CPS, single phase. Output is 300 v. dc, 0-400 ma. Regulation is ½% for no load to 300 v., or for 105-125 v. line



variations. Ripple is less than 80 mv, and power consumption is 300 watts. Within 1%, voltage output remains constant from −65°C to 85°C. Dimension are 9 x 5 5/8 x 5⅞ in., and weight is 8.5 lbs. Price is $125.—**Mercury Electronic Co., Red Bank, N.J.**—TELE-TECH

High-Vacuum Rectifier

Model GL-6087 full-wave, high-vacuum rectifier is designed for use in aircraft power supply units of moderate current requirements. It may be used as a replacement for the 5Y3GT. The tube may be used in applications which are subject to altitudes as high as 60,000 ft. It will withstand a peak impact acceleration of 700 G in any direction. Through use of a unipotential cathode which is internally connected to the filament, excessive surge voltages across the filter input capacitors during the warm-up



period are avoided. Maximum ratings include a peak inverse plate voltage of 1400 v. at altitudes up to 60,000 ft. and a steady-state peak plate current of 375 ma per plate. In typical operation, the dc output current is 125 ma.—**General Electric Co., Tube Dept., 1 River Road, Schenectady 5, N. Y.**—TELE-TECH

The ONLY COAXIAL CONNECTOR with All of these Features . . .

Quick Connect-Disconnect

Basic elements of the Type 874 connector: inner conductor, outer conductor and supporting polystyrene bead. The overlapping portion of the connection is a uniform coaxial section

Identical Connectors
— No male-female parts

Low VSWR *less than 1.05 to 4,000 Mc*

Unparalleled convenience in use and excellent electrical uniformity at all frequencies from 0 to 5,000 Mc, make the Type 874 Coaxial Connector the ideal laboratory connector. Intended for the laboratory rather than for the field, it is designed for quick connect and disconnect instrument-use and not as a system connector with locking junctions and pressurizing.

★ *Complication of male and female assemblies is completely eliminated — all Type 874 Connectors are identical and plug smoothly into each other — connections can be broken quickly and conveniently — no intermediate elements needed*

★ *Strong friction grip is made by multiple spring-loaded contacts — no special tools or locking required*

★ *Reflections are small — they can be neglected in most measurements — VSWR is less than 1.05 to 4,000 Mc.*

★ *External fields from connector are negligible*

★ *Characteristic impedance 50 ohms — the Industry and Armed Forces standard*

★ *Basic connector is inexpensive; only $1.25*

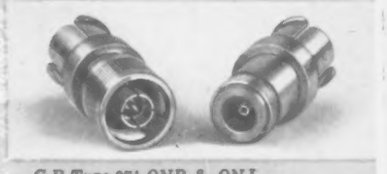
★ *Type 874 Connectors are made in several models for mounting on panels or for connecting to solid outer connector or flexible coaxial lines. They all accept Type 274 banana plugs for low-frequency use*

★ *Type 874 Connectors are also available in G-R Coaxial Elements and systems of all kinds, including such items as slotted lines, attenuators, thermistor mounts, stubs, tees and many other line elements.*

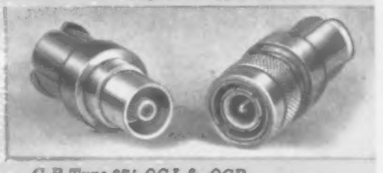
The excellent electrical characteristics of the Type 874 Connector, along with the variety of measuring instruments available, make this very flexible equipment ideal for measurements in the v-h-f and u-h-f bands

NEW Adaptors

from Type 874 Connectors to male and female versions of the Type N, Type C, Type BNC and UHF Connectors for easy use with other equipment

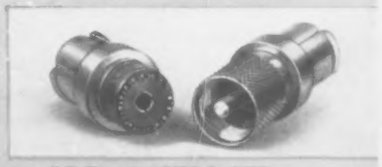


G-R Type 874-QNP & -QNJ
Adaptor to Type N Connector



G-R Type 874-QCJ & -QCP
Adaptor to Type C Connector

G-R Type 874-QBJ & -QBP
Adaptor to Type BNC Connector



G-R Type 874-QUJ & -QUP
Adaptor to UHF Connector

GENERAL RADIO Company

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WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

THAW REALLY STARTS—The FCC Commissioners and staff have carried on at full speed the processing of the uncontested applications for television stations, both VHF and UHF, since October 20, without consideration of those applications which will require hearings and decisions on the granting or denial of channels. Paper work by the applicant stations and by the FCC was thus reduced to a minimum to permit the Commission to approve speedily the uncontested applications.

750 TV APPLICATIONS, 300 UHF—The new policy has enabled the FCC to sanction video stations in many communities which did not have TV service. More than 750 station applications, including around 300 UHF, constituted the backlog of the FCC at the press deadline of TELE-TECH and, while the applications were continuing to flow in during October, the Commission cut back the backlog by its speeded-up processing of uncontested station applications.

FCC AIDED BY INDUSTRY'S ENGINEERS—The television engineering experts of the manufacturing and telecasting industries have given the FCC substantial assistance in the Commission's problems in its formulation of rules on television-receiver engineering standards. The problems which the industry experts have endeavored to solve with the best engineering standards feasible have been on VHF and UHF oscillator radiation, interference resulting from television sweep circuit radiation, spurious receiver responses and radiation from tuners and adapters being developed to enable existing VHF sets to receive UHF video signals.

RTMA COMMITTEE TESTS RADIATION—The engineering committee of the Radio Television Manufacturers Association has completed tests on 1952 television receivers to see whether they have met the radiation standards recommended by RTMA, and made its report to the FCC late in October. The RTMA engineering group also was slated to submit recommendations on UHF receiver standards on radiation during the early part of November.

ALMOST COMPLETE OVERHAUL—Through its own research and development programs and close cooperation with the communications-electronics industry in the design and production of equipment for military needs, the U. S. Army Signal Corps since the end of World War II has almost completely overhauled its procurement items to give the military forces the most improved and modernized equipment available and, at the same time, has effected substantial economies, reducing expenditures by millions of dollars.

KOREAN ELECTRONICS SURPASSES WORLD WAR TWO—The Signal Corps' progress has meant that the military forces in the Korean fighting have radio and electronic apparatus and systems which are to a major degree superior to those used in combat operations during World War II. Emphasis in the modernization and improvement of the apparatus has been to make the equipment lighter in weight, more rugged and efficient and able to withstand all ranges of climate and temperatures. The electronic-radio manufacturing industry has contributed many most valuable suggestions for expediting production and improvement of the equipment for the combat troops.

THEATER TV—By the end of this year the American Telephone & Telegraph Co. plans to supply the motion picture industry with useful costs data on broadband microwave radio relay systems for the transmission of color video programs to film theaters. This has narrowed down the areas of disagreement between the A.T.&T. and the motion-picture industry on future plans for theater television.

NEW MOBILE FIELD—With equipment suitable for mobile radio service in the 450-460 megacycle band becoming available in quantity, and with the new FCC rules for that frequency range providing greater flexibility in frequency assignments, this band is seen as the next spectrum operating space for many of the mobile radio services which have reached saturation in operation in the heavily used VHF frequencies.

NEW ASSIGNMENTS—Five radio services—the domestic public, remote pickup broadcast, industrial, land transportation and public safety, such as police and fire departments—are slated to receive new frequency assignments in the 450-460 mc band as soon as the FCC rules for such allocations are finalized during early November.

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Washington, D. C.

ROLAND C. DAVIES
Washington, Editor

new!

UNITED High Voltage Power Diodes

Much Smaller—Same Ratings

TYPE 577
New small version of 371-B

TYPE 578
New small version of 8020

TYPE X-22
New small version of 1616

Illustrations show relative sizes

AIRBORNE radar and other electronic equipment can be made much smaller and lighter by use of these modern, smaller tubes. UNITED has designed types 577, 578 and X-22 as exact electrical replacements for JAN preferred list types 371-B, 8020 and 1616, in applications where space and weight conservation is important.

Write for full specifications.

UNITED ELECTRONICS, 42 Spring Street, Newark 2, N. J.

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TELE-TECH's NEWSCAST

WCEMA to Celebrate Tenth Birthday

Plans to celebrate the tenth anniversary of the West Coast Electronic Manufacturers' Association, including the declaration of an "Electronics Week," Nov. 10-14, are announced by Leon Ungar, WCEMA president.

Formed in 1943 when the rapid growth of the industry during World War II showed the need for such an organization, the WCEMA currently comprises more than 100 corporate members representing the largest radio-electronic manufacturers in the West.

Highlighting the celebration will be the dinner at the newly-completed Hotel Statler in Los Angeles, Thursday, Nov. 13.

Present at the dinner will be industrial, civic and governmental leaders, including the past presidents of the WCEMA.

The WCEMA, which also sponsors the annual Western Electronic Show and Convention, is a trade organization whose members employ more than 32,000 workers along the West Coast. It is comprised of two councils, the Los Angeles Council and the San Francisco Council.

AES Convention Program

The fourth annual convention of the Audio Engineering Society will be held in conjunction with the Audio Fair at the Hotel New Yorker in New York City, Oct. 29-Nov. 1. According to lastest information received, the technical papers listed below supplement the program on pages 89 and 106 of the Oct. 1952 issue of TELE-TECH.

"Constant-Current Operation of Power Amplifiers," H. T. Sterling, Waveforms, Inc., and A. Sobel, Freed Radio Corp.
"Some Consideration Regarding Volume Production of Electronic Musical Instruments," G. H. Hadden, Minshall-Estey Organ, Inc.
"Intermodulation Measurements," H. H. Scott, Hermon Hosmer Scott, Inc.
"Comparative Study of Methods for Measuring Nonlinear Distortion in Broadcasting Audio Facilities," D. E. Maxwell, General Electric Co.
"Attenuator Types and Their Applications," C. F. Scott, Daven Co.
"Network Transformations," L. Norde, Hammarlund Mfg. Co.
"Binaural Sound Reproduction at Home," H. T. Sherman, Sherman Studio.

UHF 15KW KLYSTRON

Full-scale model of GL-6241, GE's new 15 KW klystron developed by Varian Associates of San Carlos, Calif. on display at the recent National Electronics Conference in Chicago. John E. Nelson of Schnectady, N. Y. points out features of new tube which measures 4½ ft. long, and weighs 200 lbs. WHUM-TV of Reading, Pa., will be first UHF station to employ this tube type.

12TH TV TECHNICAL TRAINING PROGRAM AT RCA

Foreign broadcasters attending the 12th TV Technical Training Program sponsored by RCA Engineering Products Dept. examine UHF filter and diplexer system at Camden plant. E. T. Griffith explains details to (l to r) Jose Tores, Havana, Cuba; Eduardo Cabrera, Caracas, Venezuela; J. P. Diaz-Delgado, Havana, Cuba; and Jose Marcano, Caracas, Venezuela. 94 broadcast engineers attended this course and nearly 800 have attended previous courses.

New Computing Center

Armour Research Foundation's computing services have been unified in a new Computing Center. It is set up as a section of the Electrical Engineering department, with David Rubinfein as supervisor. The new section's computing services will be available to business and industry as well as to the Foundation. Additional equipment has been ordered to enlarge the facilities of the Center.

Coming Events

Oct. 29-November 1—Audio Fair, Sponsored by AES, Hotel New Yorker, New York, N. Y.

Nov. 5-7—IMS, 16th Annual Time and Motion Study Clinic, Sheraton Hotel, Chicago, Ill.

Nov. 7—IRE, Microwave Professional Group Symposium on Microwave Circuits, Auditorium, Western Union Telegraph Co., 60 Hudson St., New York, N. Y.

Nov. 21-22—IRE, Kansas City Section, 4th Annual Regional Papers Technical Conference, President Hotel, Kansas City, Mo.

Nov. 24, 25—AIEE Electronic Instrumentation in Medicine Conference, Hotel New Yorker, New York City.

Dec. 3-5—Third annual IRE Professional group on Vehicular Communications, Washington, D. C.

Dec. 10-12—IRE-AIEE Computers Conference, Park Sheraton Hotel, New York, N. Y.

Jan. 14-16—IRE-AIEE Meeting on High Frequency Measurements, Washington, D. C.

Feb. 4-6—IRE-AIEE Western Computer Conference, Hotel Statler, Los Angeles, Calif.

Feb. 5-7—West Coast Audio Fair, Los Angeles, Calif.

March 23-26—IRE National Convention, Grand Central Palace & Waldorf-Astoria Hotel, New York, N. Y.

April 18—Cincinnati Section, IRE, Seventh Annual Spring Technical Conference.

April 26-30—SMPTE 73rd Convention Hotel Statler, Los Angeles, Calif.

April 28-May 1—NARTB 1953 Convention, Biltmore Hotel, Los Angeles, Calif.

May 18-21—Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.

AES: Audio Engineering Society
AIEE: American Institute of Electrical Engineers
IRE: Institute of Radio Engineers
IMS: Industrial Management Society
NARTB: National Association Radio and Television Broadcasters
RTCM: Radio Technical Commission for Marine Services
RTMA: Radio-Television Mfrs. Assn.
SMPTE: Soc. of Motion Picture and TV Engineers

As old as

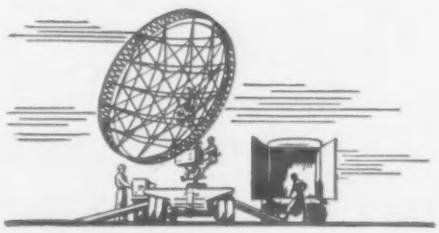
RADIO

yet as young as

ELECTRONICS...

AEROVOX
CAPACITORS

1922 At the very dawn of radio—30 years ago, Aerovox came into being to meet capacitor needs. Pioneer radiophone transmitters and earliest radio receivers specified Aerovox capacitors. Such collaboration has continued down through the first three decades of radio-electronic progress.



1952 Today, giant atom-smashing betatrons . . . radar gear spotting unseen targets . . . transoceanic radio-guided rocket bombs . . . world-wide radio communications . . . electronic computers reducing thousands of calculation man-hours to mere seconds . . . the modern miracle of television — for all facets of the Electronic Age, Aerovox capacitors are still engineered to customer specifications.

Indeed, from tiny precision "ceramics" and metallized-paper "space-savers," to giant power-handling "oils" and "micas," Aerovox remains the time-proven source for ALL capacitor needs.

Sub-miniature vitrified ceramic terminal end-seal Type P123ZN Aerolene-impregnated metallized-paper tubular capacitor.

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"Cinerama" Picture and Sound Heighten Realism

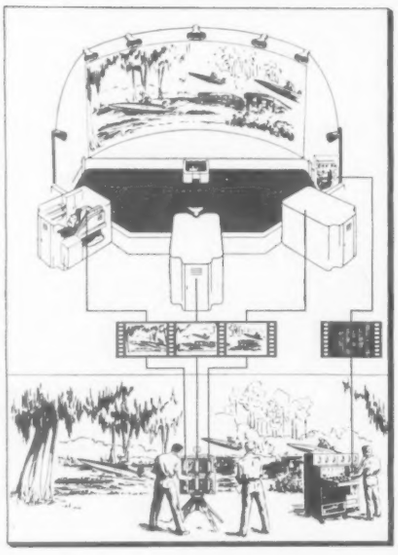
An unconventional motion picture projection system called Cinerama — a combination of the words cinema and panorama — was revealed to the public for the first time on Sept. 30 1952, at the Broadway Theatre in New York City. An enthusiastic audience applauded the realistic effect produced by the panoramic display and stereophonic sound.

The concave Cinerama screen, 64x23 ft., is six times larger than an ordinary screen, and covers 49 ft. across the front of the theatre in a 146° arc. Three separately located 35-mm projectors 48° apart throw a tri-panel picture on the wide-angle screen, each synchronized projector covering about one third of the total area. Although this display is not stereoscopic, a three-dimensional effect is achieved because the viewer observes a much wider sweep of picture than is customary. The semicircular screen, made of 1100 strips of perforated tape, gives the illusion of depth by the stimulation of peripheral vision. That is, part of the picture is seen out of the "corner of the eye" similar to the way the eye usually sees objects off to the side of its central focus.

One small defect noted was the slight jitter of one projected panel relative to the adjacent picture panel. Also, color brightness in highlight areas was not exact for all three picture panels. However, these minor shortcomings are far overshadowed by the vivid effect produced.

In conjunction with Cinerama, which was invented by Mr. Fred Waller, a Reeves stereophonic sound system is employed. Eight loudspeakers are mounted around the theatre to produce the effect of sound coming from the action on the screen, or from the side or behind the audience. Six sound tracks on a single strip of magnetic film, as originally recorded by six strategically placed microphones, are used.

It is conceivable that a system similar to Cinerama will eventually be used in TV. Perhaps it will take the form of a semicircular CRT whose display would be projected on a second screen of opposite curvature.



Three Cinerama cameras record scene, which is later projected on curved screen. Six mikes record sound on magnetic film, and booth at right controls playing through eight speakers. Center booth controls projector synchronization

1953 IRE Fellow Awards Made to 49 Members

The Institute of Radio Engineers has bestowed the membership grade of fellowship on 49 prominent radio engineers. Presentation of the awards will be made during the IRE Convention at the annual banquet in the Waldorf-Astoria Hotel, New York City, March 25, 1953.

Edward W. Allen, Jr., Chief Engineer, Federal Communications Commission, Washington 25, D. C.

Jean P. Arnaud, Head, Microwave Dept., Direccion General Fabricaciones Militaros, Cabildo 65, Buenos Aires, Argentina.

Benjamin B. Bauer, Vice-President, Shure Brothers, Inc., 225 W. Huron Street, Chicago 10, Ill.

J. W. Bell, Plant Manager, Smith & Stone, Ltd., Georgetown, Ontario, Canada.

Leonard J. Black, Professor, Electrical Engineering, University of California, Berkeley, California.

H. G. Booker, Professor, Dept. of Engineering Physics & School of Electrical Engineering, Cornell University, Ithaca, New York.

William E. Bradley, Director of Research, Philco Corp., C & Tioga Streets, Philadelphia, Pa.

John L. Callahan, Assistant to Director, Radio Research Laboratory, RCA Laboratories Division; Assistant to Vice-President in Charge of Research and Development, RCA Communications, Inc., 66 Broad St., New York 4, New York.

K. A. Chittick, Manager, Television Receiver Engineering, RCA Victor Division, Camden, New Jersey.

Arthur A. Collins, President, Collins Radio Co., 855 35 St., N.E. Cedar Rapids, Iowa.

Edward U. Condon, Director of Research & Development, Corning Glass Works, Corning, N. Y.

W. W. Eitel, president, Eitel-McCullough, Inc., San Bruno, California.

Harry Faulkner, Deputy Engineer-in-Chief, British Post Office, Alder House, Oldersgate St., London, E.C. 1, England.

Enoch B. Ferrell, Switching Research Engineer, Bell Telephone Laboratories Inc., Mountain Ave., Murry Hill, N. J.

Warren R. Ferris, Electronic Scientist, Naval Research Laboratory, Washington 25, D. C.

Lyman R. Fink, Manager, Engineering, Receiver Dept., General Electric Co., Electronics Park, Syracuse, New York.

Lawrence R. Hafstad, Director of Reactor Development, Atomic Energy Commission, Washington, D. C.

F. Hamburger, Jr., Professor, Electrical Engineering, Johns Hopkins University, Charles & 32 Sts., Baltimore 18, Md.

Lewis B. Headrick, Manager, Cathode-Ray Tube Development, RCA Victor Division, New Holland Pike, Lancaster, Pa.

Philip J. Herbst, Technical Administrator Standard Products, Engineer, RCA Victor, Division, Camden 2, N. J.

John Hessel, Chief, Radio Communications Branch, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Hans E. Hollmann, Scientist, U. S. Naval Air Missile Test Center, Point Mugu, Calif.

T. A. Hunter, President, Hunter Manufacturing Co., Iowa City, Iowa.

Eric J. Isbister, Engineering Dept. Head for Radar, Sperry Gyroscope Co., Division of Sperry Corp., Great Neck, L. I., N. Y.

Edward C. Jordon, Professor of Electrical Enigneering, University of Illinois, Urbana, Ill.

Frank G. Kear, Partner, Kear and Kennedy, 1302 18th Street, N.W., Washington 6, D. C.

Ronold W. P. King, Gordon Mackay Professor, Applied Physics, Cruft Laboratory, Harvard University, Cambridge, Mass.

Royce G. Kloeffler. Head, Dept. of Electrical Engineering, Kansas State College, Manhatten, Kansas.

Edmund A. LaPort, Chief Engineer, RCA International Division, 30 Rockefeller Plaza, New York 20, N. Y.

Russell R. Law, Research Engineer, RCA Laboratories Division, Princeton, N. J.

William A. MacDonald, President, Hazeltine Electronics Corp., 58-25 Little Neck Pkwy., Little Neck, L. I., N. Y.

Jack A. McCullough, Vice-President, Eitel-McCullough, Inc., San Bruno, Calif.

J. A. Morton, Technical Staff, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey.

Allen B. Oxley, Chief Engineer, RCA Victor Co., Ltd., 1001 Lenoir St., Montreal, P.Q., Canada.

Albert Preisman, Consulting Engineer, Vice-President in Charge of Engineering, Capitol Radio Engineering Institute, 3224 16 St., N.W., Washington 10, D. C.

John C. R. Punchard, Chief Engineer, Communications Equipment Div., Northern Electric Co., Ltd., 250 Sydney St., Belleville, Ontario, Canada.

Jan A. Rajchman, Research Engineer, RCA Laboratories Division, Princeton, N. J.

J. A. Ratcliffe, Reader, Physics, Cambridge University, Cambridge, England.

Stephen O. Rice, Technical Staff, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N. Y.

Walther Richter, Consulting Electrical Engineer, 5426 N. Kent Ave., Milwaukee 11, Wisconsin.

A. A. Roetken, Technical Staff, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey.

William M. Rust, Jr., Chief, Geophysics Research Sec., Humble Oil &

(Continued on page 86)

Sylvania to Serve West Coast Electronics Market from California Location

Sylvania has announced that construction is under way on a modern, completely equipped Electronics Division plant and laboratory in Mountain View, California.

This up-to-date facility of 35,000 square feet is being made available to West Coast manufacturers as a source of electronic components including semiconductor devices, microwave components, and special purpose tubes.

A research and development laboratory will be included to handle design and applications problems on these and other related products.

The addition of this California location to Sylvania's existing electronics facilities marks another step in the company's long-term plan to provide the finest quality products and fastest service to all markets.

For complete information on Sylvania Electronic Products, write Dept. E-2911 Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

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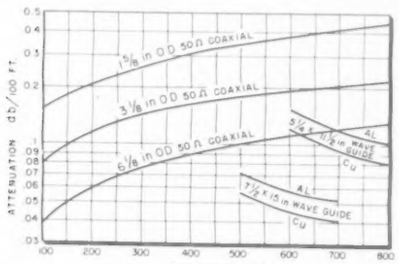
Waveguide Transmission Lines for UHF

The advent of UHF telecasting poses the problem of selecting the most desirable type of transmission line system to feed the broadcasting antenna. Primarily, the choice lies between two media: well-established coaxial cable, and waveguide which is still in the developmental stage. The overall objective of transmission line design is to maximize the system's power output, and this is accomplished better by



Attenuation characteristics of coaxial cables compared to aluminum and copper guides at UHF

waveguide than coax—but not without introducing several new problems.

The two basic criteria which affect the utilization of transmission lines are losses and reflections. If power is reflected, the vswr is raised, which reduces the power-handling capacity of the line. Furthermore, if reflected energy is not absorbed by the transmitter, it can give rise to a ghost on the TV receiver. Power losses or attenuation, needless to say, are an expensive waste of r-f power. Economic and structural problems are other salient considerations in choosing the most desirable type of transmission line.

Discussed below are the pros and cons of using waveguide, as compared to coax, in the UHF region.

PRO

Attenuation at UHF is considerably less for waveguide than coax, as shown in the accompanying chart. Copper losses in coax are enhanced by the skin effect, heating the conductors and reducing the power handling to about one-half of the VHF rating.

Reflections and impedance instability are often caused by center conductor eccentricities in coax—a factor with which waveguide does not have to contend. Since the amount of dielectric support of the center conductor is limited by capacity and impedance considerations, the conductor is susceptible to lateral movement with resulting drop in impedance and rise in vswr. For example, a ⅛-in. shift in 1⅝-in. coax yields a vswr of 1.05. A 0.4-in. shift can drop the impedance of this same 50-ohm line to 20 ohms. On the other hand, a stable vswr of 1.01 is attainable with waveguide.

Unwanted higher mode is an ever-present menace above 750 MC when 6⅛-in. coax is used, the line approaching a point where it can operate as a waveguide. The TE_{11} mode may be uncoupled to the radiating system or combine with the desired coaxial mode to yield partial cancellation and, hence, reflection. Mode suppressors may be developed, but they would add to the cost and complexity of the installation.

Capacitance of coax dielectric bead supports, which may be considered as distributed at VHF, must be looked upon as lumped elements at UHF. Another problem in coax design is that undercutting the beads to reduce reflections raises the cost. So a major advantage of waveguide is—no center conductor.

CON

Manufacturing methods and tolerances are presently a serious deterrent to large-scale waveguide production. RTMA has established three commercial sizes:

7½ x 15 in.—470- 750 MC
5¾ x 11½ in.—640- 960 MC
4⅞ x 9¾ in.—750-1120 MC

These may be made by sheet metal techniques, deep drawing, or by stretching and forming available piping, but the best method is somewhat undecided. Also, the RTMA proposed standard of ± 0.015 in. tolerance is very tight for deep-drawn and extruded stock.

Structural problems such as added weight, wind loading and differential thermal expansion are introduced when guide is mounted on the antenna tower. This can mean that stronger, and more expensive, towers would be required.

Choice of materials is still not thoroughly resolved. Low-attenuation copper requires some reinforcing; strong steel guide might prove too heavy; and lightweight aluminum has slightly more attenuation than copper-clad steel.

IRE Fellows

(Continued from page 84)

Refining Co., P. O. Box 2180, Houston 1, Tex.

Jorgen Rybner, Professor, Telecommunications, Royal Technical University of Denmark, Oester Voldgade 10 G. Copenhagen K. Denmark.

Daniel Silverman, Exploration Research Director, Stanolind Oil & Gas Co., P. O. Box 591, Tulsa, Oklahoma.

Archie W. Straiton, Professor, Electrical Engineering Research Laboratories, University of Texas, Austin, Tex.

Irven Travis, Director of Research, Burroughs Adding Machine Co., 511 N. Broad St., Philadelphia, Pa.

Bertram Trevor, Engineer, RCA Laboratories Division, Princeton, N. J.

Harry W. Wells, Research Staff Member, Carnegie Institution of Washington, D. C., Broad Branch Rd., N.W., Washington 15, D. C.

Charles J. Young, Research Section Supervisor, RCA Laboratories Division, Princeton, N. J.

Powered Metal Processing

Increasing interest in the techniques used in manufacturing odd-shaped magnetic cores made of pressed powdered iron focuses attention on the primary methods of making powdered metal. According to F. J. Stokes Machine Co., the atomizing, reduction and electrolytic deposition methods account for 90% of powdered metal production in the U. S.

Atomizing is principally used for metals with low melting points, such as lead, tin, aluminum and brass. The melted metal is poured in a thin stream into a high-speed stream of air, gas or water-spray, creating a shower of droplets which strike a collector as tiny solid particles. A variation of this economical method draws heated air and melted metal through an atomizing nozzle.

Reduction is the most widely used method for copper, iron and tungsten. Oxides of the metal are derived from ores by roasting or chemical means, and then ground to powder in a ball-mill. This is reduced to metal in a hydrogen atmosphere furnace, although certain iron oxides are reduced by carbon dioxide from coke. The resulting particles are spongy, and are said to have good "green strength," i.e., they knit together to form a good mechanical bond after pressing.

Electrolytic deposition is similar to electroplating, except that high amperage is used to create gassing and produce a powdery or brittle deposit instead of a solid coating. Copper, mechanically vibrated from the cathode, costs about the same as in the reduction process. Iron powder made by deposition is more expensive, but increased purity and softness enhance conductivity. Iron may be flaked off and ground in a ball-mill. Annealing is often required to reduce brittleness.

Making powdered iron parts at Lenkurt Electric

New Name and Building

Concurrent with ground-breaking for a new building, Waveline, Inc., has announced the change to its present name from the former Microwave Equipment Co. However, the firm will retain the same address as before, P. O. Box 470, Caldwell, N. J.

RESEARCH — DEVELOPMENT — PRODUCTION —

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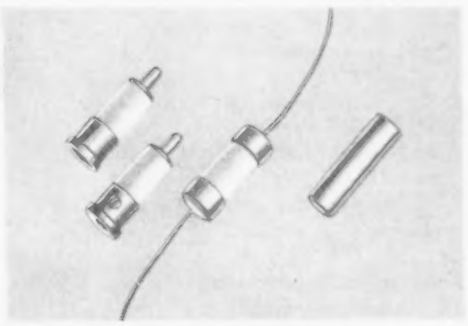
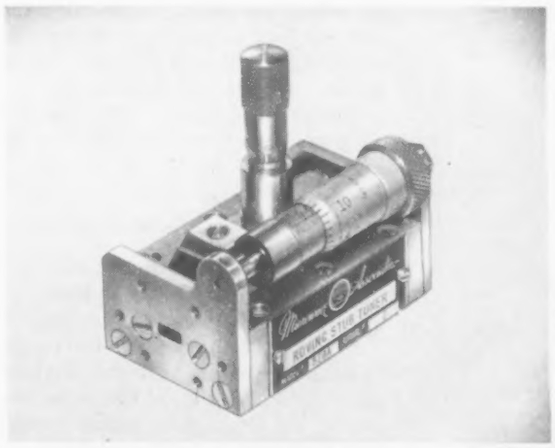
LOOK FOR THE TRADEMARK

SEMICONDUCTORS

MICROWAVE is establishing new production facilities to supply a complete semiconductor line including 1N21B, 1N21C, 1N23B, 1N25, 1N26, and special millimeter wave silicon diodes. Production will commence shortly on — n-p-n TRANSISTORS under license to The Western Electric Company.



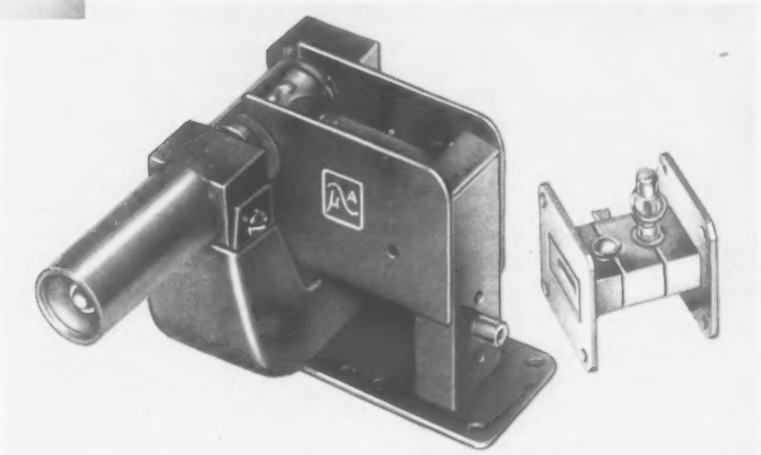


WAVEGUIDE COMPONENTS AND TEST EQUIPMENT

Our competent MICROWAVE component group specializes in the 3 cm and millimeter region producing duplexers, mixers, attenuators, roving stub tuners, frequency meters, standing wave detectors, dry and water loads and other excellent components.

MAGNETRONS AND GAS DISCHARGE TUBES

The seasoned MICROWAVE tube engineering and production teams are now producing several magnetron types including the popular 2J42 and 2J42A. High level TR microwave gas discharge switching tubes are available for several bands. Our research personnel in this field are always ready to assist in special microwave tube design problems.



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(*Continued from page* 68)

dicted performance have been encountered. Application has been made to the following systems.

It is often necessary to signal mobile receivers by group, or service function. Investigation indicated that a maximum number of 10 such groups need be signaled.

The audio signal to perform this function in the receiver is derived from an attenuator which bridges the output of the discriminator. It is thus free from variations due to operator adjustment of volume controls, etc. A short audio signal is applied to a vacuum tube switch which is sensitive to presence of tone and carrier. Simultaneous presence of tone and carrier closes the switch and opens the audio circuits; the carrier then holds the circuit closed. Release of the carrier opens the circuit and reblocks the audio circuits.

The variations inherent in mobile receivers make essential an audio signal approximately 10 db greater than that required to operate marginally with all conditions at normal design centers. This 10 db margin accounts for filament and B+ variations, r-f signal level changes, tube and component variations, and temperature drift.

A typical Selective Dispatch system block diagram is shown in Fig. 6. The audio tone selected by the push-buttons is introduced by the C contact in the microphone circuit. Closing the PTT picks up a relay

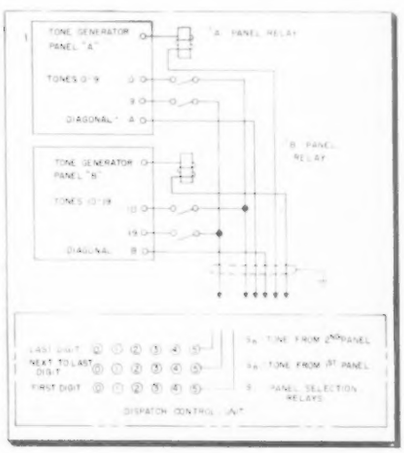

Fig. 9: Diagonal call digit-code system

which holds in for approximately 0.5 second and then releases. The tone level is adjusted to rated deviation of the system by the *only* adjustable control in the entire system.

The selective dispatch system has been typically used for alerting Volunteer Fire Department receivers which are on the police frequency. Until a fire call is sounded the receivers are silent, then the tone signal opens the receiver and keeps it open as long as required. It has been used to split taxi fleets into area groups, public utility systems into functional groups; any system in which delineation by function improved efficiency and utilization of the radio frequency channels.

Duplex Selective Dispatch

The similarity between the circuits of the tone generator and the selective amplifier would imply that a tone generator could be made from a selective amplifier by com-

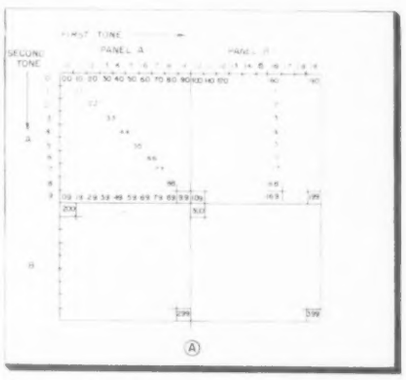

Fig. 10: (a) Tone generator panel arrangement

pleting the regenerative feedback path through an AGC circuit. In the Duplex Mobile Selector, the path is completed to and from the regenerative AGC by relay contacts. The relay is energized momentarily by closing the PTT circuit, at the same time the microphone circuit is interrupted and the tone generated is fed into the speech input circuits at proper level. The microphone circuit is interrupted for only one-half second maximum, a negligible amount of lost time. See Fig. 7.

Tone Signals

This arrangement permits tone signals to be transmitted in both directions and hence a closed system. Skip signals are particularly annoying to low-frequency station operators since station antenna are usually high-gain and well-located. It is not at all uncommon for such stations to suffer continuous interference periods lasting for days. The Duplex Selective Dispatch system permits all receivers in a

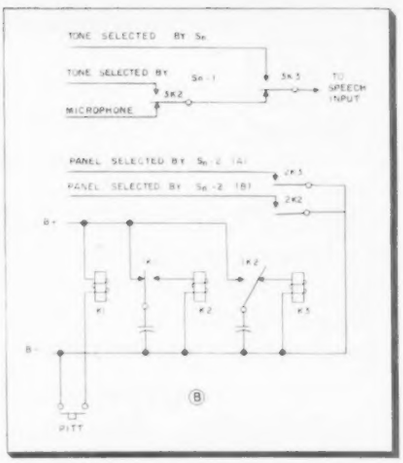

Fig. 10: (b) Tone selection relay system

given system to be silent except when traffic originating in that system is on the air.

Typical applications which come to mind are utility systems which are subject to substantial interference, taxi systems which operate on frequencies whose congestion is unbelieveable, and to keep the list of uses under control, Mobile Relay systems.

Selective Calling

In contrast to the previously described group selective system, the selective calling system is an individual selection out of the entire fleet. As nearly as possible, the basic ideas which underlie the telephone system are used, even to the point of "busy signal" if such is required.

The Mobile Selector contains two selective amplifiers, one is always open and the second is blocked. Two tones are transmitted in proper order of the frequencies to which the selective amplifiers are tuned by the plug-in selective networks. The first tone is amplified by the open selective amplifier, whose output is then applied as an unblocking signal to the second selective amplifier. The second tone is then amplified by the second selective amplifier and applies an operating signal to a vacuum-tube relay stage. The relay then closes alarm, voice coil, or other circuits as required. The possible modes of operations are limited only by the discipline which may be enforced on the fleet. The simplified schematic of Fig. 8 shows the selector.

The distinguishing feature of the Selective Calling system we have designed is the logical method by which the tones are selected and transmitted. There are some 80 tones available in the audio band,

(*Continued on page* 90)

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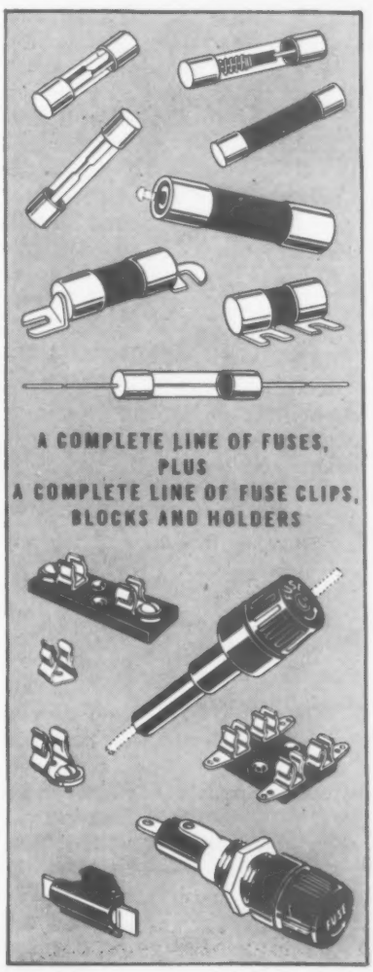

The most vital quality of a fuse is *dependability*, for the sole purpose of a fuse is to protect wiring and equipment far more costly than the fuse itself.

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VOICE SIGNALING

(*Continued from page 88*)

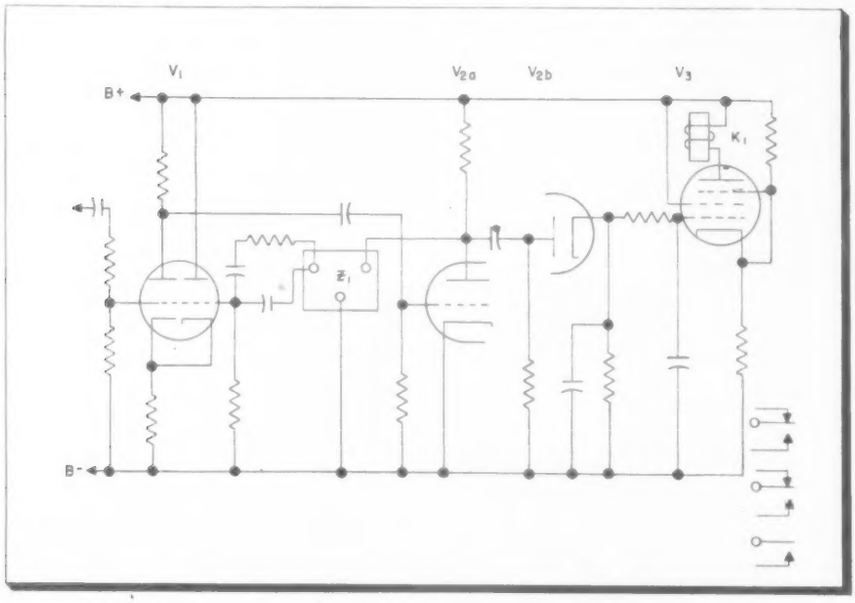

Fig. 11: Tone-operated switch combines selective amplifier and vacuum tube switch

which would yield some 6400 calls. At first glance it would seem resonable to number the tones and establish arbitrary correlation, such as Car 31—Code 16 4. Such a random code is neither logical nor readily expandable, besides requiring a translation directory in constant use by the operator.

We felt that an approach which leads to a logical direct code must be developed to satisfy all requirements. This is the method:

1. The number of push-button rows in the dispatch selector is the same as the number of digits in the call number.
2. Two of the rows of 10 push-buttons select tones in decimal combination out of a block of ten tones, hence each block contains 100 calls. This establishes the last *two* figures of the call number.
3. The first push-button row selects the particular block of 100 calls, i.e., it establishes the *first* significant figure of a three digit code. In case the code is a four digit one, then the combination of the first two rows establish the first two rows establish the first *two* significant figures of the code.
4. What is called a diagonal call occurs when the last two digits of the call are the same—it implies that the same audio tone must be transmitted twice in succession. Since this is an unworkable combination a simple artifice is employed. Whenever any push button in the next-to-the-last row is depressed, the tone corresponding to that push button is automatically removed from the corresponding position in the last row, and a diagonal digit is inserted. This corresponds to multiplying by eleven. Fig. 9 shows the fundamental idea just described.

Dispatch Control Unit

The basic building block of the dispatching system is the dispatch control unit described and panels of 11 tone generators. Since the two tones are transmitted in sequence, the first significant figures of the code may be described in terms of the order in which the panels of eleven tones are picked up. This is accomplished by placing on each panel a relay with 10 A-contacts. Energizing this relay connects the tone generators to the 10 tone-lines for the hold-in period of the relay. This may best be explained by tracing the operation for a typical number.

Typical Operation

Suppose we wish to call 168 (Fig. 10a):

The digit 1 indicates the panels pick up B A.

The digit 6 indicates selection of the 6th tone in panel B.

The digit 8 indicates selection of the 8th tone in Panel A.

Closing the PTT picks up K1 (Fig. 10b), K1 picks up K2 which holds in for 0.3 seconds and Panel B is switched into circuit.

K2 relaxes and K3 picks up (for approximately 0.2 second) switching into circuit panel A.

The similarity of these ideas to those embodied in telephone-type panel-dial-switching systems has been pointed out as an important consideration. As a matter of interest, the code selection may be readily performed via a dial telephone.

Not obvious is the fact that all tones but the one in use at a given instant are shorted to ground, thus eliminating crosstalk in tone circuits. Since all of the tone panels feed the line in parallel thru the relays previously mentioned it is clear that a great economy in circuits is possible even though as many as 80 tones may be used. The number of tone circuits remains constant.

The Selective Calling system has shown itself to be extremely reliable in actual use over a long period of time. The design has shown itself to be conservative and readily adaptable to variety of receivers.

Tone-Operated Switch

The combination of a selective amplifier and a vacuum tube relay circuit to form a tone-operated switch for individual switching functions has proven to be a very important use. Schematically, one of these is shown on Fig. 11.

The outstanding features of the tone-operated switch are flexibility and simplicity. Switches have been used singly and in combination to perform a wide variety of control and signalling functions. The primary use at the present time is in conjunction with Civil Defense. In this use Civil Defense receivers are tuned to the local public safety frequency and held silent until an alarm is sounded. When an alarm is sounded the relay is energized and alarm sirens, lights, etc., are energized.

One distinctly unusual use has been control VHF equipment over 500-mi. carrier telephone circuits using 750 CPS as the control frequency. The stable high Q of the circuits has resulted in operation free of voice-triggering and of excellent reliability.

We have surveyed the development and application of a voice-frequency tone signaling system which results from reduction-to-practice of feedback-type selective circuits. These circuits are stable, reliable and economical. The resulting devices are readily adaptable to a wide, and as yet not completely explored, variety of applications.

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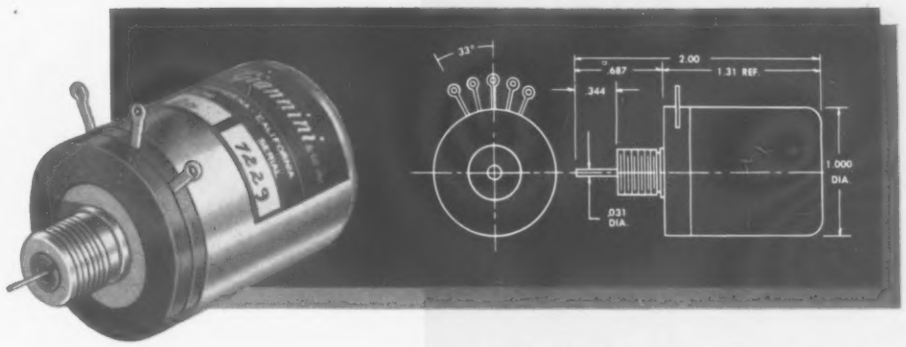

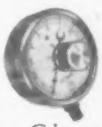

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LINEARITY: ± 0.5% of total resistance.

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10,000	.003	1,000	1300	10	$40.00
25,000	.003	1,000	1300	7	$45.00

**Must be de-rated for ambient temperature over 60° C.

***Prices apply to quantities of six or less. For quotation on larger quantities or special types, please write.

Above Microtorques* are available in the following two types: Type 2: 270° + 10° − 0° Electrical Rotation, Mechanical Rotation. Limited by internal stops.

Type 9: 354° Min. Electrical Rotation, Mechanical Rotation. Continuous. Brush does not short ends of coil.

Giannini also produces potentiometers of various types, including non-linear functions, and tapped windings.

For information on this and other fine instruments write Dept. P. G. 1

Giannini INSTRUMENT-QUALITY **POTENTIOMETERS**

*MICROTORQUE—*T.M. REG. 1952

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY

2nd Annual Computer Meet to be Held Dec. 10-12

Following the pattern of last year's successful meeting in Philadelphia, the Second Annual Computer Conference and Exhibition will be held in New York City's Park Sheraton Hotel, Dec. 10-12, 1952. Jointly sponsored by the Institute of Radio Engineers, American Institute of Electrical Engineers, and the Association for Computing Machinery, the three-day conference features input and output equipment used with the many different computing systems.

At-the-door registration fee is $3.50, while advance registration is $3.00. Cost of the Proceedings of the 1952 conference is $4.00 when ordered after Dec. 6; $3.50 in advance. All checks should be made payable to Ralph R. Batcher. Further information and registration cards may be obtained from Mr. A. C. Holt, IBM, 590 Madison Ave., New York 22, N. Y.

Listed below is the advance technical paper program of the 1952 Joint AIEE-IRE-ACM Computer Conference:

Wednesday, December 10

"Recording Techniques for Digital Coded Data," by Arthur W. Tyler, Eastman Kodak Co.
"Converters for Teletype Tape to IBM Cards," by G. F. Nielsen, International Business Machines Corp.
"Punched Card to Magnetic Tape Converter for UNIVAC," by E. Blumenthal & F. Lopey, Eckert-Mauchly Div. of Remington Rand Inc.
"Devices for Transporting the Recording Media," by Richard L. Snyder, Jr.
"Buffering Between Input-Output and the Computer," by Alan L. Leiner, National Bureau of Standards

Thursday, December 11

SEAC INPUT-OUTPUT SYSTEM
"SEAC Input-Output System," by Sidney Grunwald, NBS
"Input-Output Devices Used with SEAC," by James L. Pike, NBS
"Auxiliary Equipment to SEAC Input-Output," by Paul A. Mantek, NBS
"Operating Experience," by Ernest Ainsworth, NBS
UNIVAC INPUT-OUTPUT SYSTEM
"The Uniservo-Tape Reader and Recorder," by H. F. Welsh and H. Lukoff, Eckert-Mauchly Div. of Remington Rand Inc.
"Input Devices," by L. D. Wilson and E. Roggenstein, Eckert-Mauchly Div., Remington Rand Inc.
"Output Devices," by E. Masterson and L. D. Wilson, Eckert-Mauchly Div., Remington Rand Inc.
RAYDAC INPUT-OUTPUT SYSTEM
"RAYDAC Input-Output System," by Walter Gray and Kenneth Rehler, Raytheon
"System Design," by Louis Fern, Raytheon
"Operating Experience with RAYDAC," by Frank Dean, Raytheon
IBM 701 INPUT-OUTPUT SYSTEM
"Type 701 Input-Output Organization," by L. D. Stevens, IBM
"Type 726 Magnetic Tape Reader and Recorder," by W. S. Buslik, IBM
"Magnetic Tape Techniques and Performance," by H. W. Nordyke, IBM

Friday, December 12

"Survey of Analog-to-Digital Data Converters," by H. E. Burke, Consolidated Engineering Corp.
"Survey of Mechanical Type Printers," by J. Hosken, A. D. Little, Inc.
"Survey of Nonmechanical Type Printers," by Lt. R. J. Rossheim, George Washington U.
"Anelex Printer," by Leo Rosen, Anderson-Nichols Co.
"Eastman Printer," by Russell G. Thompson, Eastman Kodak Co.
"Ferranti Input-Output Equipment," by Bryan W. Pollard, Ferranti Ltd., London
"Garment Tag Equipment," by O. G. Hessler, Sears Roebuck and Co.
"Numerically Controlled Machine Tool," by William Pease, MIT
"Summary and Forecast," by Samuel N. Alexander, NBS

IMPROVED ION-TRAP TEST

Close-up of ion-trap test position at Round Lake, Ill. plant of Heppner Mfg. Co. Faster and more accurate indications of the strength of the ion-trap magnetic field are now obtained by placing trap over motor-driven alternator, and then reading output voltage on meter. This method eliminates any magnetization effects on the testing apparatus.

TELE-TECH'S Guide to Latest UHF Receiving Tubes

Description	6AF4 RCA, Sylvania, GE UHF Miniature triode oscillator List Price: $3.90		6AJ4 GE UHF miniature triode amplifier and grounded-grid amplifier List Price: $6.00	6AM4 GE UHF triode grounded-grid mixer List Price: $6.00	6AN4 Sylvania UHF triode grounded-grid amplifier or mixer List Price: $3.90	6BZ7 CBS-Hytron UHF twin triode amplifier for cascode operation List Price: $3.05		6T4 Sylvania UHF miniature triode oscillator
Heater Voltage (v.)	6.3		6.3	6.3	6.3	6.3		6.3
Heater Current (ma)	225		225	225	225	400		225
Bulb	T-5½		T-6½	T-6½	T-5½	T-6½		T-5½
Base	Min. but. 7-pin		Min. but. 9-pin	Min. but. 9-pin	Min. but. 7-pin	Min. but. 9-pin		Min. but. 7-pin
Basing Design	7DK		9BX	9BX	7DK	9AJ		7DK
Mounting Position	any		any	any	any	any		any
Max. overall length (in.)	2⅛		1¾	1¾	1¾	2-3/16		1¾
Max. seated length (in.)	1⅞		1½	1½	1½	1-15/16		1½
Max. diameter (in.)	¾		⅞	⅞	¾	⅞		¾
Characteristics	Class A_1 Amp.	950 MC osc.	Class A_1 Amp.	Mixer	Amp.	Class A amp. (each section)		Osc.
Plate Voltage (v.)	80	100	125	150	200	150		80
Cathode Bias Resistor (ohms)	150		68	100	100	220		150
Amplification Factor	15		42	85	70	38		13
Plate Resistance (ohms)	2270		4200	9500	7700	5600		1800
Transconductance (μ mhos)	6600		10,000	9000	9000	6800		7000
Plate Current (ma)	16	22	16	7.5	13	10		18
Grid Voltage (v)		—4	—9	—5		—11		—15
Grid Resistor (ohms)		10,000						
Plate Current (μa)		400	10	10		10		50
Maximum Ratings, Design Center Values		950 MC osc.				(each section)		
Plate Voltage (v.)		150	150	150	300	250		200
Plate Dissipation (watts)		2.25	2	2	5	2		3.5
Cathode Current (ma)		28	20		30	20		30
Heater-cathode voltage (v.)		80	80	80	100	200		200
Plate Input (watts)		2.5						
Grid Voltage (v.)		—50						
Grid Current (ma)		8						8
Grid Circuit Cathode Bias (megohms)		0.5						
Interelectrode Capacities (μμf) Unshielded						UNIT #1	UNIT #2	
Grid to Plate	1.9				1.7	1.15	1.15	1.8
Input	2.2				2.2	2.85		2.4
Input (grounded grid)					4.8		4.95	
Output	0.45					1.35		0.45
Output (grounded grid)					1.8		2.27	
Plate to Cathode			0.18	0.16	0.17	0.15	0.15	
Heater to Cathode			1.7	1.8	2.8	2.2	2.3	
Cathode to Grid and Heater			4.4	4.4				
Plate to Grid and Heater			2.4	2.4				

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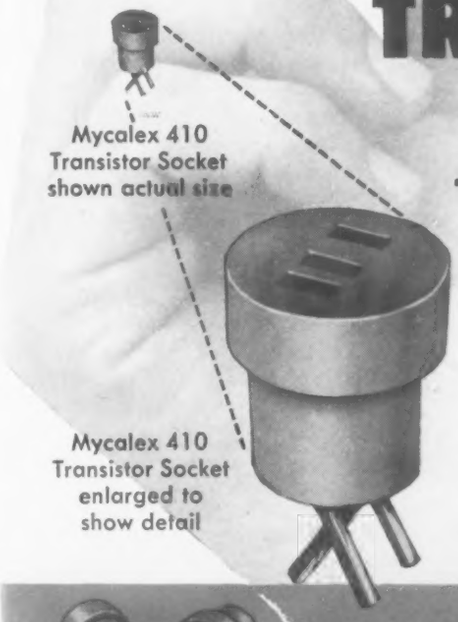
TRANSISTOR SOCKETS

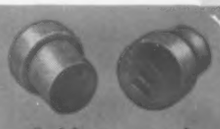


Mycalex 410 Transistor Socket shown actual size

Mycalex 410 Transistor Socket enlarged to show detail

—now in the pilot production stage
—engineered in advance of actual need

In keeping with the MYCALEX policy of progressive design in advance of needs, these Transistor Sockets were engineered months ago and are now in small scale pilot production. They'll be available in quantity in advance of actual needs.

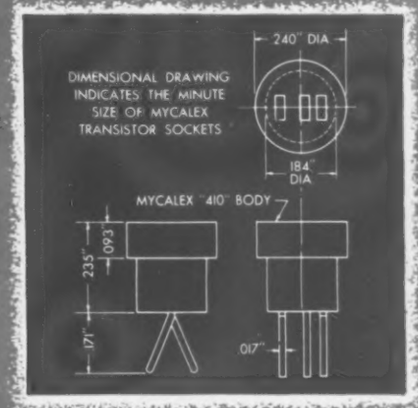


Achievement in
PRECISION MOLDING!

The production of Mycalex Transistor Sockets is a real accomplishment of precision molding in miniature. The holes for the leads are the smallest ever molded. All tolerances are exceedingly close. Mycalex production engineers are proud of their achievement . . . particularly because low-cost, mass production techniques can be adhered to.

The body is precision-molded of MYCALEX 410, glass-bonded mica insulation for lasting dimensional stability, low dielectric loss, immunity to high temperature and humidity exposure combined with maximum mechanical strength. The loss factor is only 0.014 at 1 MC and dielectric strength is 400 volts/mil.

Contacts can be supplied in brass or beryllium copper. The sockets are readily solderable. The socket bodies will not warp or crack when subjected to high soldering temperature. They function in ambient temperatures up to 700° F.



Mycalex Low-loss Tube Sockets and Multiple Headers

A complete line of tube sockets including sub-miniature types is available in Mycalex 410 and Mycalex 410X glass-bonded mica insulation. Comparative in cost to ordinary phenolic sockets they are far superior in every respect. Dimensional accuracy is unexcelled. For complete information on standard and custom Tube Sockets or Multiple Headers, call, wire or write . . . there is no obligation, of course.

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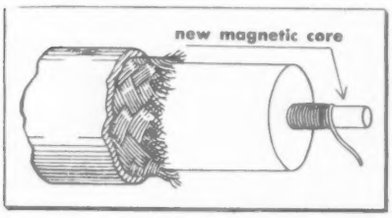
Delay Cable

Delay cable type HH-1500 features a flexible, low-loss magnetic core which nearly triples the inductance of the cable assembly,



while substantially maintaining the dimensions and the attenuation characteristic of conventional high-impedance cables, such as RG-65/U. The nominal electrical characteristics are as follows: characteristic impedance, 1500 ohms; capacitance, 49$\mu\mu$f/ft. delay, 0.073 μsec/ft.; attenuation, 6.0 db/100 ft at 1 MC; dc resistance, 7.0 ohms/ft.; and max. operating voltage, 2000 v. rms. The cable is built around a flexible magnetic core whose diameter is 0.115 in. and which carries a closely coiled inner conductor of #32 AWG wire. Over the helix is a spacer of "Flexit" polyethylene whose outer diameter is 0.285 in. and which serves as a core for the braided outer conductor. The cable is covered with a polyvinyl chloride jacket of 0.405 in. outside diameter.—**Columbia Technical Corp., 5 E. 57 St., New York 22, N. Y.**—TELE-TECH

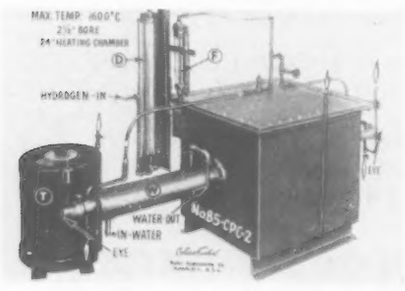
Miniature Twin Diode

Type 5726 miniature twin diode for detectors is a "premium" version of the 6AL5W, and is suitable for mobile and aircraft use.

Tungsten heaters are internally connected in series for fail-safe operation. Heater rating is 6.3 v., 0.3 amp. Resonant frequency is 700 MC. Using the small-button miniature 7-pin base and T-5½ bulb, its maximum overall length is 1¾ in., seated length 1½ in., and diameter ¾ in. Shock impact tests show 700 G max., and vibration 2.5 G max. As a half-wave rectifier, peak inverse plate voltage is 360 v. max., peak plate current/plate 60 ma, and dc output current/plate 10 ma.—**Tube Dept., Radio Corporation of America, Harrison, N.J.**—TELE-TECH

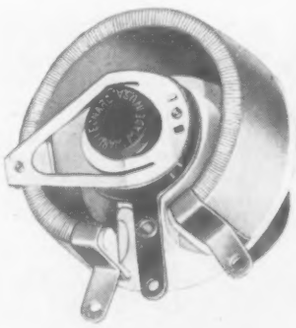
Degasifying Furnace

Degasifying Furnace for the radio tube and metallurgical industry. It can be used for small metal parts which have to be surface cleaned and degasified for further processing. It is constructed as a complete unit with the gas drying tower and flow control gauge mounted on the furnace top and the temperature regulating transformer placed anywhere. The furnace has a 24 in. long heating chamber, while the diameter of the heating chamber can be made to the work required in the range from 1 to 12 in. Maximum temperature is 1600°C. Gases for surface cleaning and degasing in use for this furnace are hydrogen, nitrogen, or any other inert gas. Operation of the furnace is as follows: Hydrogen passes through chamber to drive out air. Then the furnace is heated. A load of parts is put into the heating chamber, while a new load is inserted into the heating chamber.—**Eisler Engineering Co., 750 S. 13 St., Newark 3, N. J.**—TELE-TECH



Ring Type Rheostats

New 25 and 50 watt Vitrohm ring type rheostats feature contact arm and drive shaft assembly that furnishes smooth, close control with no backlash. A balanced spring steel contact arm that maintains uniform contact pressure is interlocked directly to a Mycalex insulating hub molded to the drive shaft. Both core and base are molded of high density, low porosity and high dielectric strength ceramic. High stability resistance wire, wound toroidally on the core, is held secure by vitreous enamel. Bulletin 1110 ring rheostats are designed for rheostat or potentiometer use in control equipment. Watt ratings are based on 300°C rise in 40°C ambient. Resistance values for the 50 watt size range from 1 to 7500 ohms. Standard resistance tolerance +20, −10%.—**Ward Leonard Electric Co., Mount Vernon, N. Y.**—TELE-TECH



Cathode-Ray Tubes

Line of "tight tolerance" industrial cathode-ray tubes makes possible high precision measurements. Presently available are Types AWP, 5 ADP and 5 XP-A. Among the important features are: reductions by 50% in critical tolerances for deflection sensitivities and grid cutoff; improved perpendicularity between "X" and "Y" deflection plates by 300%; greatly improved sensitivity on both axes without reduction in useful scan and flat face plates to reduce parallactic error. The new tubes are improved over previous tubes so that characteristics such as deflection linearity, pattern distortion, modulation, line width and light output are now specified.—**Tube Div., Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.**—TELE-TECH

Solderless Terminal

Solderless terminal for intricate control panel wiring is known as the reinforced "Ampli-Bond" terminal. Design assures that no underlying conducting surface will be exposed even if the insulating sheath is pierced. This is accomplished by means of an insulated metal ring near the base of the insulation support sleeve. The ring gives all necessary strength to combat vibration and sharp bending, but does not communicate with the electrical connection farther up the barrel. Terminals are available in the 12-10 and 16-14 HD sizes, but in the near future they will be available in smaller wire sizes. They are color coded for easy identification.—**Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa.**—TELE-TECH

FOR MORE INFORMATION

on New Equipment for Designers and Engineers

See pages 72-74, 76, 78

Computer Potentiometers

(*Continued from page* 54)

Two steps are taken to reduce the noise caused by formation of oxide films on the wire, the first being, naturally, to select the resistance wire alloys which are least susceptible to corrosion or oxidation. This is not always possible since it is sometimes necessary to base the selection of the wire alloy on other considerations, such as temperature coefficient and resistivity. It can be said generally that nichrome V, a nickel-chrome alloy which does not contain any iron, probably has the greatest resistance to corrosion and oxidation of any of the high-resistivity commercially available resistance alloys. The platinum alloys offer even better characteristics in this respect, but unfortunately are of considerably lower resistivity and higher temperature coefficient. Manganin wire, which is often highly desirable because of its very low temperature coefficient and almost negligible thermal emf against copper, unfortunately oxidizes very rapidly even under ideal conditions, and is generally not recommended for use in precision types of potentiometers, where the contact pressures must be kept low for long life and minimum torque. Some consideration has actually been given in certain cases to the use of a hermetically-sealed pot containing inert gas, where alloys susceptible to oxidation must be used.

Most precision pot manufacturers today apply a light film coating of an oxide inhibitor or lubricant to the resistance elements during the assembly process. These coatings are quite successful in delaying the formation of oxide films, and also in reducing electrical noise by smoother operation of the sliding contact. However, these inhibitors tend to dry out, and the best of the lubricating materials available today cannot be counted upon to remain effective for more than six months or a year.

A third variation of dynamic electrical noise is actually random emf's generated due to the heat of friction caused by the sliding contact moving over the coil. This is known as the Tribo effect and its reduction or elimination is sometimes effected by proper selection of sliding contact materials to match with resistance wire alloys. For some alloys, the greatest reduction can be attained by the use of contacts made from the same alloy, while in others such choice actually leads to higher

(*Continued on page* 96)

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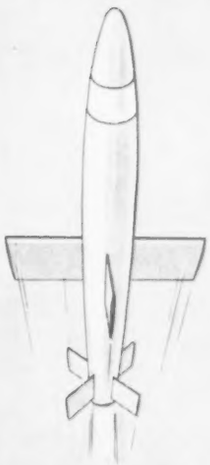
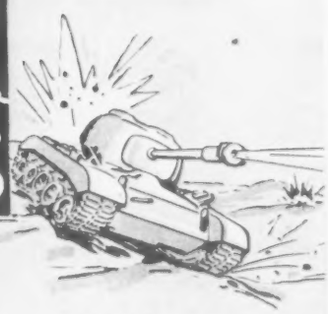
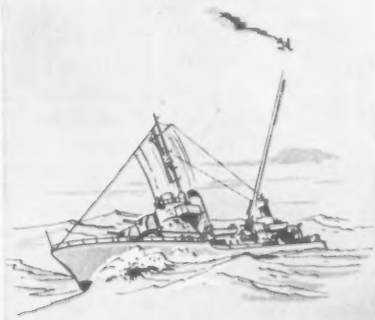


Controlling guided missiles in flight

Knowing your whereabouts under all circumstances



Stabilizing the guns on bouncing tanks



Shooting down jet planes from the unstable decks of ships

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Take one part of the fantastic, mix thoroughly with Ford's engineering and production ability, and you've got the answer to another "impossible" automatic control problem. That has been the sum and substance of the Ford Instrument Company since 1915.

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From the more than 16 acres of floor space that make up the engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical and electronic instruments that bring us our "tomorrows" today! Research, development, design and production are being applied to control problems of both Industry and the Military.

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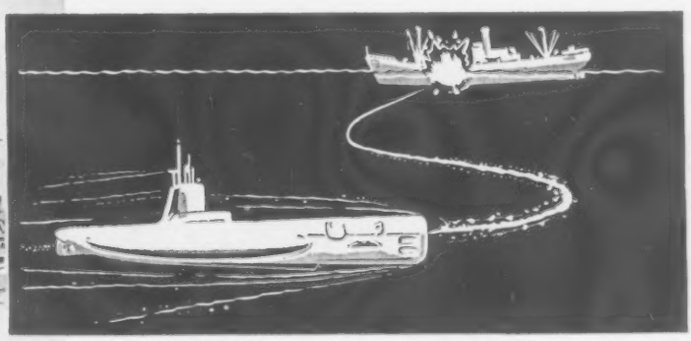

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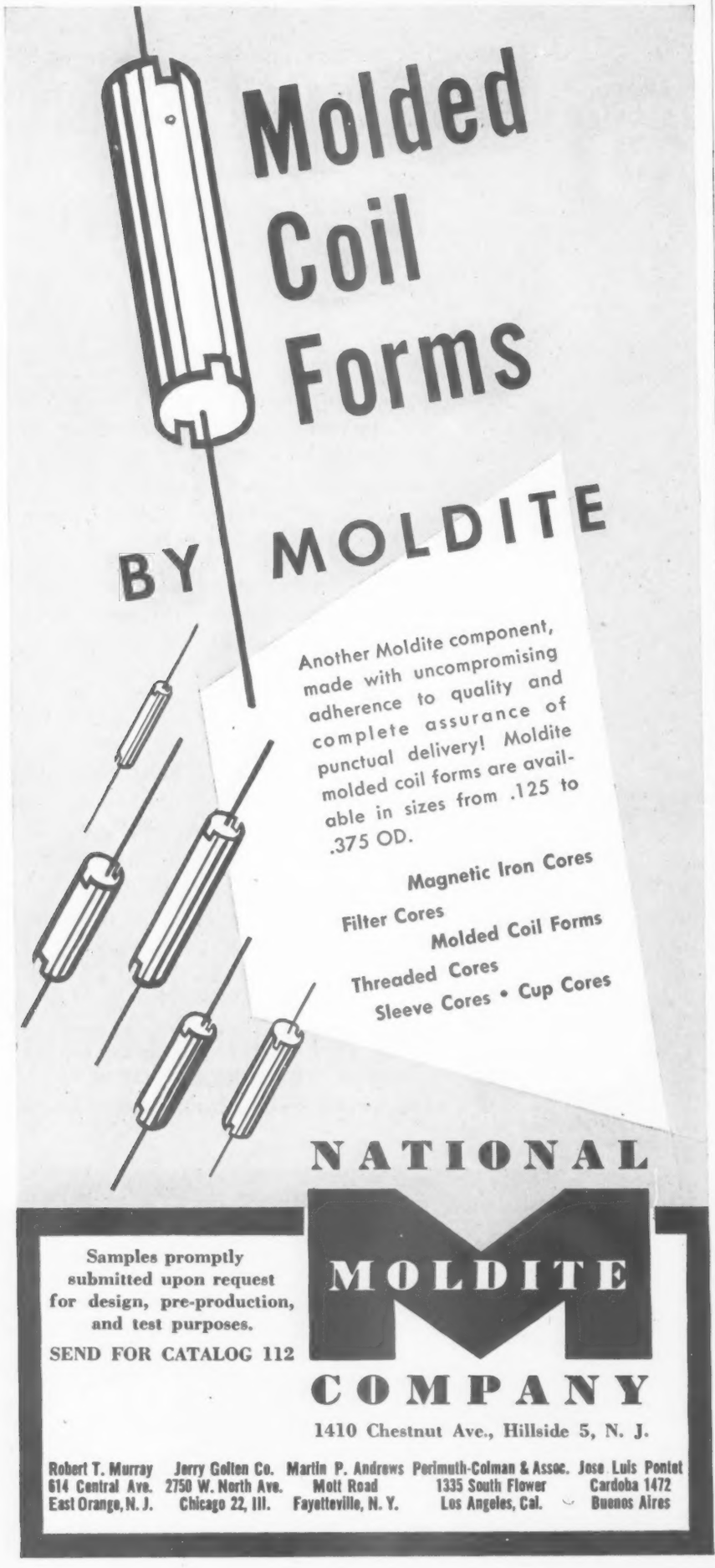
Build a future for yourself as an engineer at Ford. If you qualify there's a lifetime opportunity on automatic equipment design with the top name in automatic control. Write for our informative, illustrated brochure.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Another Moldite component, made with uncompromising adherence to quality and complete assurance of punctual delivery! Moldite molded coil forms are available in sizes from .125 to .375 OD.
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emf's. Since this Tribo effect is due to friction-generated heat at the contact, it is natural that the effect will vary in direct proportion to the speed of contact movement.

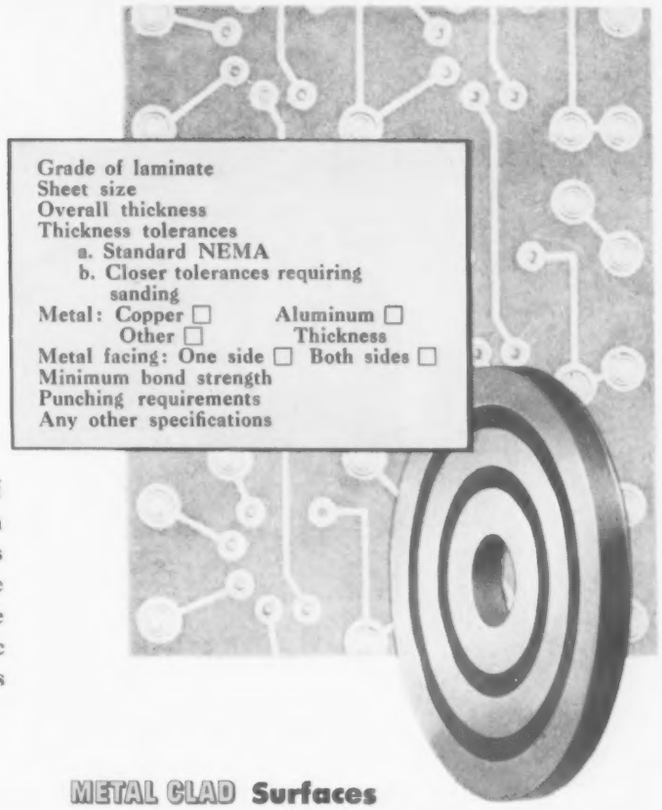
An additional source of error is sometimes unknowingly introduced into potentiometer applications by the method in which the pot is employed in its circuit. With a constant potential impressed across the coil of a linear pot, the voltage output from the slider will not vary linearly with respect to its position along the coil if current is drawn through the slider. This characteristic is commonly referred to as "loading error." The error varies with slider position, being zero at both ends of rotation, and having a maximum value at approximately two-thirds rotation from the end of zero voltage. Fig. 9 illustrates a typical circuit employing a pot wherein the voltage is impressed across the complete coil of the pot and the sliding contact feeds into one end of a load. Unless this load is sufficiently high to reduce the slider current to negligible values, loading error will result. The position, as well as the magnitude of maximum error, varies with the relative resistance of the load to the potentiometer resistance. With a load resistance ten times that of the pot, the maximum error is about 1.45% of the applied voltage, and occurs at 66.9% rotation. With a load of one hundred times the pot resistance, the maximum error is reduced to 0.15% and occurs at 66.7% rotation. Depending upon the linearity accuracy which is desired, then, the load resistance should be one hundred times that of the pot, or greater. If both the potentiometer and load resistance are fixed values, and give a ratio less than this, it is possible to reduce the resulting error by resistive padding, while if the signals from two potentiometers are being compared, the loading error can be cancelled by loading the two proportionately.

It should be recognized that, since the slider contact is in a position to suffer the greatest wear through operation, its life, and hence that of the pot itself, will vary somewhat in proportion to the physical length of the resistance element. It can be seen that any given slider contact could last through many more revolutions if it were travelling over a coil only a few inches than it could over a coil of many feet. Generally, wire-wound precision pots available today, with elements of from five- to ten-inch lengths, can be expected to perform satisfactorily over from 1,000,000 to 3,000,000 cycles under

(*Continued on page* 98)

Information Wanted...

about your uses for C-D-F METAL CLADS



Grade of laminate
Sheet size
Overall thickness
Thickness tolerances
a. Standard NEMA
b. Closer tolerances requiring sanding
Metal: Copper ☐ Aluminum ☐
Other ☐ Thickness
Metal facing: One side ☐ Both sides ☐
Minimum bond strength
Punching requirements
Any other specifications

Did you know that C-D-F supplies a full range of metal clad laminates in both Dilecto and Teflon grades? With mounting interest in printed circuits it pays to consider the respective advantages of these new C-D-F materials . . . it also pays to line up all the Information Wanted facts and discuss your specific application with your C-D-F sales engineer (Offices in principal cities). He's a good man to know!

Dilecto METAL CLADS

Printed circuits depend upon stable, uniform core material and Dilecto has years of proven insulation service (Dilecto is a laminated thermosetting plastic made only by C-D-F from paper, cotton, glass or asbestos fabric base, or a mat base). Normally phenolic or melamine impregnating resins are used for METAL CLAD sheet stock. There are many grades of Dilecto, but only the better electrical grades are supplied with metal foil surfaces. Outstanding is C-D-F grade XXXP-26, a hot punching grade with high insulation resistance, low and stable dielectric losses and excellent moisture resistance. Green color. New C-D-F Catalog GF-53 gives complete data on Dilecto grades. Write for your copy today.

Teflon* METAL CLADS

Glass fiber cloth is first coated with Teflon resin and laminated into C-D-F GB-112T sheet stock. This base withstands high heat (200°C. maximum operating temperature) with the dissipation factor and dielectric constant extremely low over a wide frequency range. No adhesive film is needed to bond metal to the Teflon laminate, thus the inherently good electrical properties of the core material are maintained. GB-112T has practically zero water absorption, so a METAL CLAD with this core offers consistent high insulation resistance with excellent stability of dielectric loss properties.

METAL CLAD Surfaces

Copper foil (usually .00135" or .0027" thick) is bonded on one or both faces of the sheet grade of Dilecto selected. The foil used is a special grade of electrolytic deposition copper particularly adaptable for cementing onto laminated materials. An adhesive film is placed between the metal and the Dilecto, and cemented during the pressing and curing cycle. When closer tolerances are required C-D-F sands the Dilecto to the required thickness before bonding. Aluminum, silver, or other alloys of various metals may be supplied.

Better Bond Strengths

One of the most important physical properties of a metal clad product is its peel strength, the pounds pull required to separate the foil surface from the core material. Working with years of laminating know-how, C-D-F has been successful in obtaining the following average test values for its METAL CLAD sheet stocks:

	Lbs. pull per 1" width
XXXP-26 plus .00135" copper	5 to 8
XXXP-26 plus .0027" copper	7 to 10
XXXP-26 plus .0015" aluminum ..	9 to 12
GB-112 Teflon plus .00135" copper ..	6 to 9

Sheet sizes: Dilecto grades — 38 x 38", 38 x 42"
Teflon grades — 16 x 36"

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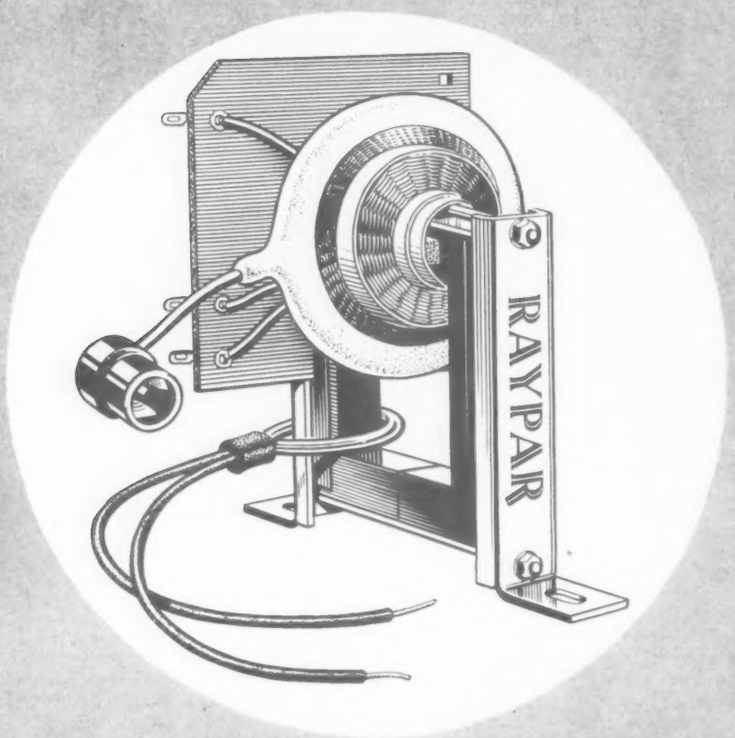

Raypar's newly developed 27" horizontal output transformer is a perfect example of RAYPAR'S electronic knowledge to produce uniform components of consistent quality for radio and television.

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normal conditions, and at rotational speeds under 100 rpm.

The lower torque requirements of precision pot design are due largely to the lighter contact pressures and sometimes to higher-quality bearings. These lighter contact pressures are actually used because of the finer resistance-wire sizes employed, and also to minimize wear on the sliding contact. Single-section precision pots will be found to have starting torques in the neighborhood of one or two in.-oz., as contrasted with anywhere from five to ten in.-oz. for the usual radio-type pot. There are, on the market today,

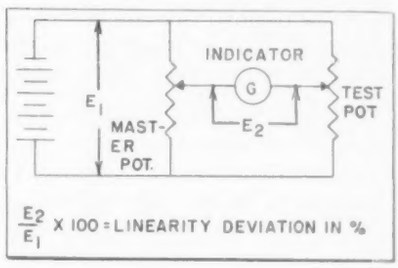

Fig. 10: Production test circuit compares voltage output of test unit with master pot

several designs of miniature ultra-low torque single-turn precision pots which find ready application in many computing systems designed to employ miniature servo motors. The small coil diameter of these miniature pots reduces the torque arm of the slider contact and further, the contacts are operated at extremely light contact pressures. These factors, combined with the use of either jewel or miniature ball bearings, reduces the starting torque in some instances to as low as .005 of an inch-ounce, and the running torque is usually almost negligible.

Precision pots, both single and multi-turn, which are now available in mass production quantities, will be found to have reliable accuracies of from 0.05% to 0.5%, depending upon size and resistance values, and several special multi-turn designs now becoming available, will have accuracies sometimes as high as ±0.01%. In these ranges, the problem of reliable and rapid calibration in production tests becomes extremely important, when it is appreciated that the test equipment should generally be at least ten times as accurate as the pot under test.

Production testing can best be accomplished by comparing the voltage output curve of the test unit

(*Continued on page* 101)

NEW 27EP4 PROVIDES GIANT-SCREEN TV AT A PRICE YOU CAN AFFORD!

TUBE PLUSSES ARE:

Extremely short length, for compact cabinet construction.

Aluminized to give you a bright, sharp picture at 16,000 v!

DESIGNERS and manufacturers now can plan production of that deluxe TV with super-size picture! Distributors will order your new set in volume, for 27EP4 cost—only *one-third* that of a 30-inch type—permits, for the first time, real giant-screen TV at a sensible retail level.

Over 400 square inches of picture, or ¾ the viewing area of a 30-inch round tube! Compact, because of the 90-degree deflection angle—so short that tube length is the same as picture width, 24 inches! Means a trimmed-down, practical cabinet.

Filter-glass face, *aluminized* for maximum brightness and contrast at moderate voltage—16,000 v, no more than a 21-inch standard tube requires for top-quality viewing!

Get all the facts without delay. Phone, wire, or air-mail *Tube Department, General Electric Company, Schenectady 5, N. Y.*

27EP4

Picture width	24 inches
Picture height	18⅛ inches
Deflection angle	90 degrees
Tube length	24 inches
Recommended operating voltage	16,000 v
Focus	magnetic
Screen	Filter glass, aluminized

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curacy, or actual calibration is known. This is accomplished by mechanically synchronizing the test and master units and applying voltage across both units from a common source. The differential voltage between the two sliders may be amplified and either presented on a crt or recorded. The schematic circuit of such a test setup is illustrated in Fig. 10. If the accuracy of the master pot is sufficiently greater than that of the unit under test, it is satisfactory to plot this error curve direct and note its maximum deviation from an assumed line of theoretical zero error. If it is necessary to utilize a master whose accuracy does not greatly exceed that of the test unit, it is possible to plot the positive and negative deviation curve of the master and then simply compare it with the curve presented by the two pots operating in synchronism.

Precision Design

Both single- and multi-turn precision potentiometers are now produced by a number of manufacturers with design features which are specifically intended for servo work. Basically, these features are concerned with higher precision of mechanical design and assembly. The higher costs involved in demanding the use of ball bearings in the precision servo pots, are not always justified by the improved results which might be obtained. It will be found in many cases that Oilite, or even the simple brass or bronze sleeve-type bearings, may permit comparatively low operating torques and even allow mechanical tolerances approaching those of ball bearings, with consequent slight reductions in cost and great reduction in delivery time. A second feature which identifies a precision-type pot as being intended for servo usage, is the flange-type of mounting which contrasts with the customary, single-hole, threaded-bushing type of mounting long employed for the ordinary radio-type component.

In very brief summary, potentiometers have recently come into their own in servo computer work because of the great strides that have been made in the improvement of accuracy, both mechanical and electrical. The precision potentiometer today offers, in many instances, greater accuracy and reliability than can be obtained by any other equivalent component or method. Nearly all of the current trend in new potentiometer design is directed toward making pots more suitable for servo work.

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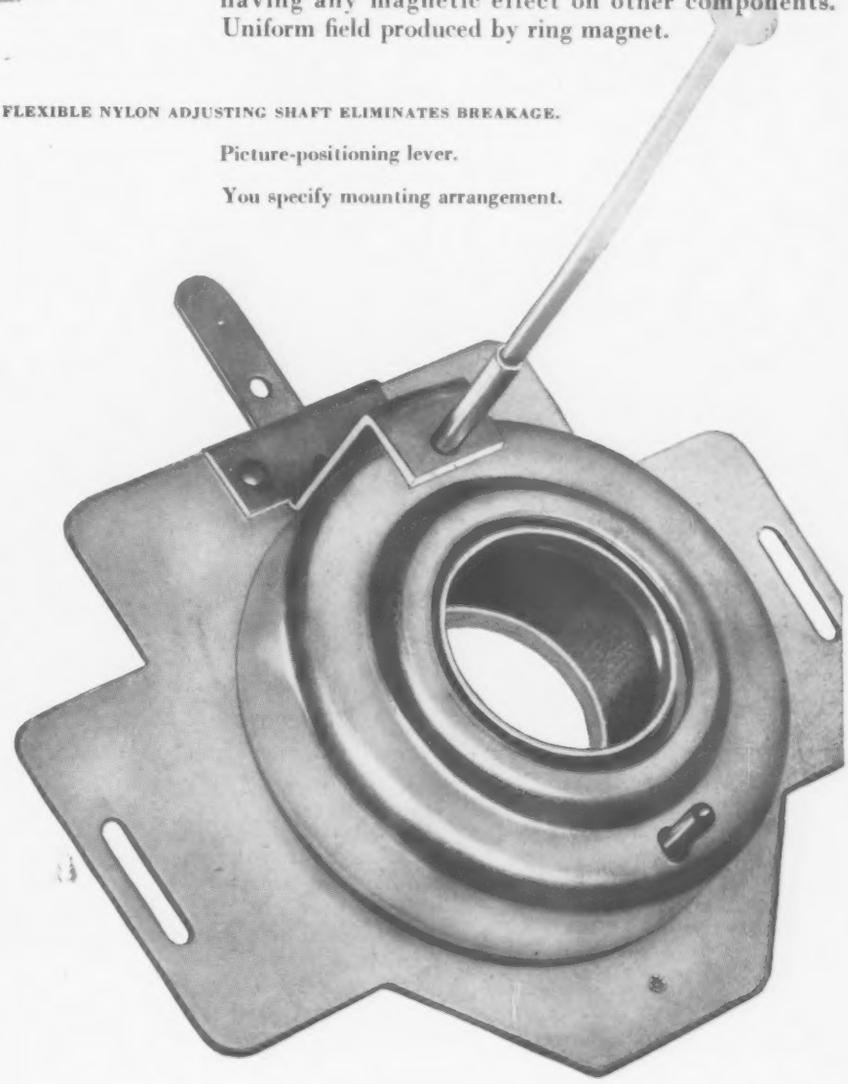

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Although several filament making and tabbing machines were already available, a recent Kahle client wanted something better. The client ordered a machine that would be more positive in operation, faster - and that would cover a greater range of filament sizes. Kahle's solution was to build the fully automatic machine shown above, Model 2036. This machine, producing 1200 to 3000 units per hour, handles coated filament wire from .0006" diameter up and cuts lengths from 14 mm. to 40 mm.

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CUES for BROADCASTERS

(*Continued from page* 61)

and reconnected as shown. The output impedance is a balanced 600 ohms, and depending on the position of switch S1-A the jack is providing either an output signal or is receiving an incoming signal for recording.

Five Dollar Opera!

A LITTLE known service of the British Broadcasting Corp. is its world wide transcription organization. In the United States, programs such as "Hamlet" or "The Marriage of Figaro" can be obtained on a transcription for only $5! For educational or university stations there is no charge save that of mailing.

Almost every conceivable type of program is covered in the 77,000 discs which were sent out last year. The service is different, in that, instead of the usual murder stories and blood and thunder productions more unusual and generally speaking, less public appeal types of program are made available by this service. Many station managers wondering what programs to use should consider checking with the BBC office in New York at 630 Fifth Ave.

Spring Speed Changer

ROBERT C. BEESON,
KCOG, Centerville, Iowa

ONE of our Presto 10 A turntables was damaged recently. The thumbnut which holds the motor engaged became stripped. The only quick repair job we could make was to install a spring to pull the motor into the engaged position. This was accomplished by lifting the platter out of the frame. The metal tab which actuates the Microswitch was removed from the motor suspension unit and the switch was shorted. (We have mercury switches to operate the turntables.) A 2 by 2 in. corner brace was bent so that it nested on the motor suspension with one leg hanging down between the motor and the turntable frame. The corner brace was drilled, stretched open and the hinged end secured to the frame of the turntable on the side opposite the motor.

A spacer block makes changing speeds easier. The spring holds the motor suspension against the speed adjustment screws and the table is left in "neutral" to prevent flat spots in the rubber tire. Changing speeds no longer requires loosening and tightening the thumbnut.

Identifying Reels of Recording Tape

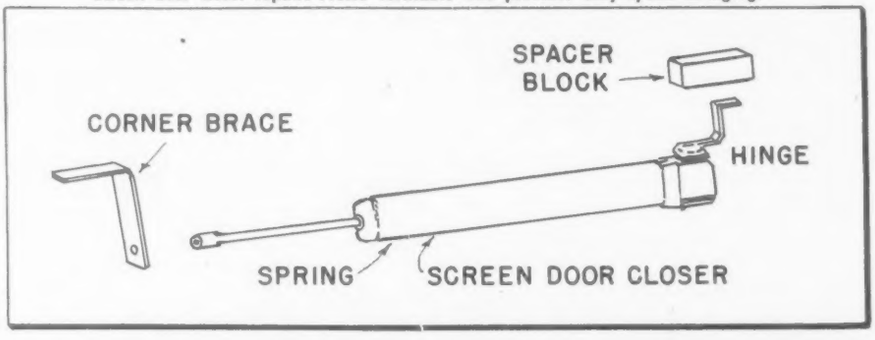
ROBERT M. HARVEY, Brown Radio Products, Inc., Nashville 3, Tenn.

TO prevent errors in programming, accidental erasure or misuse, it is vital to identify the various reels of recording used at a station or recording studio.

For temporary identification, use a "Phano" glass marking pencil to mark desired information directly on either plastic or metal reels. These pencils are available in several colors at office suppliers. A cloth, moistened with rubbing alcohol, will quickly remove markings made with them. Take care not to allow any alcohol to reach the tape because it will damage the oxide coating. And *don't* try carbon tet on plastic reels; it will etch into the surface of the reel.

For permanent use, or where a professional appearance is desired, the white self-adhesive labels available at stationers, are fine. One brand, the "Kum-Kleen," manufactured by the Avery Adhesive Label Corp., Monrovia, Calif., is available in a variety of sizes and shapes. These labels are supplied several to a small backing sheet, making them handy for use in a typewriter, or with pen or pencil. The surface of the reel should be clean and dry for best results. These labels will stay on almost indefinitely, but may be peeled off quickly when desired.

Screen door closer repairs Presto turntable and provides easy speed changing.



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GUARANTEED SPLICE-FREE

SPLIT-SECOND TIMING
with New 2¾" Hub

Timing errors are virtually eliminated by this improved reel design which minimizes tension and speed changes throughout the winding cycle. Ratio of O.D. to hub diameter is the same as on the standard NAB aluminum reel.

PERFECTED ANTI-FRICTION PROCESS. Reduces head wear—eliminates annoying tape "squeal" – prevents "tackiness" even under extreme temperature and humidity conditions.

MAXIMUM UNIFORMITY OF OUTPUT. All 7" and 10" reels of plastic-base Audiotape are guaranteed to have an output uniformity *within* ± ¼db – and reel-to-reel-variation of less than ± ½db. What's more, there's an actual *output curve* in every 5-reel package to prove it.

With Audiotape, all of these extra-value features are *standard*. There's no extra cost – no problem of separate inventories or variations in tape quality.

For there's *only one* Audiotape – the finest obtainable anywhere. Test it – compare it – let Audiotape speak for itself.

The new 7-inch plastic reel with large diameter hub for greater timing accuracy is now being supplied on all orders unless otherwise specified. Because of increased hub diameter, maximum reel capacity is slightly over 1200 feet. Older style Audiotape reels with 1¾" hub and 1250 feet of tape will continue to be furnished on request at the same price.

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	Type Number	Input Voltage Nominal Excitation	Input Current Milliamperes	Input Power Watts	Input Impedance Ohms	Stator Output Voltages Line to Line	Rotor Resistance (DC) Ohms	Stator Resistance (DC) Ohms	Maximum Error Spread Minutes
Transmitters	AY201-1	26V, 400~, 1 ph.	225	1.25	25+j115	11.8	9.5	3.5	15
	AY201-4	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	20
Receivers	AY201-2	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	45
Control Transformers	AY201-3	From Trans. Autosyn	Dependent Upon Circuit Design				42.0	10.8	15
	AY201-5	From Trans. Autosyn	Dependent Upon Circuit Design				250.0	63.0	15
Resolvers	AY221-3	26V, 400~, 1 ph.	60	0.35	108+j425	11.8	53.0	12.5	20
	AY241-5	1V, 30~, 1 ph.	3.7	—	240+j130	0.34	239.0	180.0	40
Differentials	AY231-3	From Trans. Autosyn	Dependent Upon Circuit Design				14.0	10.8	20

**Also includes High Frequency Resolvers designed for use up to 100KC (AY251-24)

AY-500 (PYGMY) SERIES

Transmitters	AY503-4	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	25.0	10.5	24
Receivers	AY503-2	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	23.0	10.5	90
Control Transformers	AY503-3	From Trans. Autosyn	Dependent Upon Circuit Design				170.0	45.0	24
	AY503-5	From Trans. Autosyn	Dependent Upon Circuit Design				550.0	188.0	30
Resolvers	AY523-3	26V, 400~, 1 ph.	45	0.5	290+j490	11.8	210.0	42.0	30
	AY543-5	26V, 400~, 1 ph.	9	0.1	900+j2200	11.8	560.0	165.0	30
Differentials	AY533-3	From Trans. Autosyn	Dependent Upon Circuit Design				45.0	93.0	30

For detailed information, write to Dept. B.

ECLIPSE-PIONEER DIVISION of Bendix AVIATION CORPORATION
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VHF and UHF Receivers

(*Continued from page* 38)

Plans are underway for tuners which may give 18 to 20 of mixed VHF and UHF channels chosen to suit the particular locality. This becomes entirely practical when the local oscillator operates in the VHF region and the UHF mixer operates with an equivalent local oscillator signal obtained from harmonics of the local oscillator. Surprisingly large harmonic powers are available from conventional VHF tube sources, e.g. one section of a 6J6 oscillator, by using a germanium or silicon diode as the harmonic generator. Of various types, the 1N34, 1N34A and 1N82 appear to be the most satisfactory, producing powers of 60 milliwatts at 500 MC and 30 milliwatts at 900 MC. This arrangement, in combination with the new silicon diode, type 1N82, provides a very stable-frequency harmonic oscillator-mixer combination.

Tuner Electrical Design

It may be of interest to summarize the basic sections of UHF tuners by dividing them into two groups:

a. The fundamental oscillator continuously tunable type,
b. harmonic generation of the local oscillator frequencies together possibly with selector switch tuning.

Fig. 2 shows the block diagram for these two basic groupings.

Both types require a high pass filter between the antenna and the first UHF tuned circuit in order to reduce interference from VHF, FM, shortwave and broadcast stations. Such a high pass filter should cut off as sharply as possible below 450 MC. Next is the radio frequency circuit, preferably double-tuned, so as to carefully match the antenna to the input impedance of the r-f amplifier tube or the mixer. Following this should be a radio frequency amplifier tube with its output tuned circuit coupled to the mixer. Next, the mixer crystal with the output i-f circuit and the local oscillator with or without the harmonic generating crystal and tuned circuit. Both the r-f and mixer tuned circuits should provide as high a discrimination against nearby local television channels as possible in order to avoid cross-modulation. Then, the image selectivity will also be adequate.

A first stage of good quality radio frequency amplification is most desirable: (1) to reduce the local oscillator coupling to the antenna; (2) to improve as far as possible, the noise factor, thereby increasing the useful range of the transmitter; (3)

(*Continued on page* 106)

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Export Division: Rocke International Corp., 13 E. 40th St., N. Y. C. *In Canada: Charles W. Pointon, 1926 Gerrard St. East, Toronto*

provide increased image rejection and, also; (4) reduce cross-modulation at the mixer.

Suitable r-f amplifier tubes at acceptable prices are not presently available. However, as is shown in Table II, some types have possibilities: (1) Planar grid triodes, similar to the rocket-tube type 5768 as described by B. F. Tyson[5], if designed and fabricated in such a manner as to be low in cost; (2) small modified travelling-wave tube suggested by Robert Adler of Zenith[6]; and (3) pencil type triode.

It is necessary to emphasize the requirement of low fluctuation noise in r-f amplifier tubes, since silicon diode mixers of the 1N82 type have already low noise factors, making it possible even without an r-f stage, to have a noise factor as low as 13 db.

Mixer

The silicon diode type 1N82 has good conversion efficiency and low noise factor. The beam deflection type of tube as described by E. Herold[7], is an unusual mixer with a low noise factor and very low oscillator coupling but somewhat expensive.

Oscillator

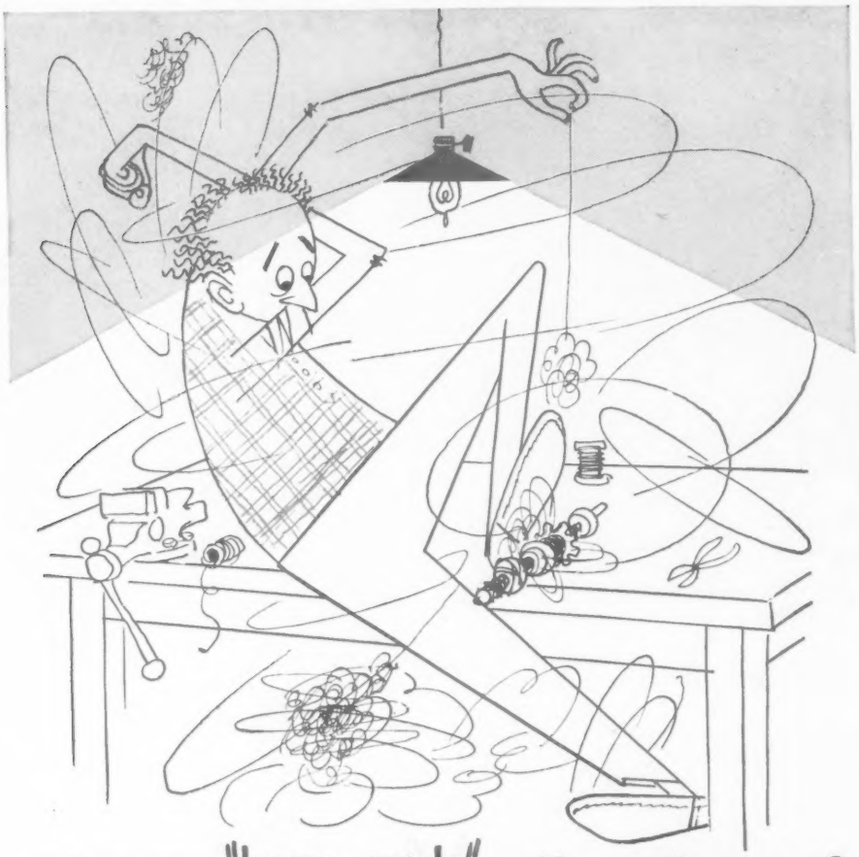
Oscillator design for the continuously tunable type can use one of several presently available UHF oscillators such as the 6T4 and the 6AF4. The stability of the oscillator is largely influenced by the circuit design and it appears that a modified butterfly type, as used by DuMont, provides good stability together with rugged mechanical design. For the harmonic generation type of circuit, a conventional VHF oscillator tube such as the 12AV7, provides ample power for the 1N34 harmonic circuit and a frequency stability better than a straight UHF oscillator throughout the whole band.

I-F Amplifier

If no r-f amplifier is to be included; and so far no commercial prototypes for the whole range—470-890 MC has an r-f stage—then it is particularly important to have a quiet first stage of intermediate frequency amplification. This stage should have the lowest possible noise factor[9] to make full use of a silicon mixer, since the i-f voltage at the output of the mixer is lower than the r-f signal voltage applied to it.

The procedure in designing the front-end for best noise factor is to first calculate the coupling network between the mixer and the grid of

(*Continued on page* 108)



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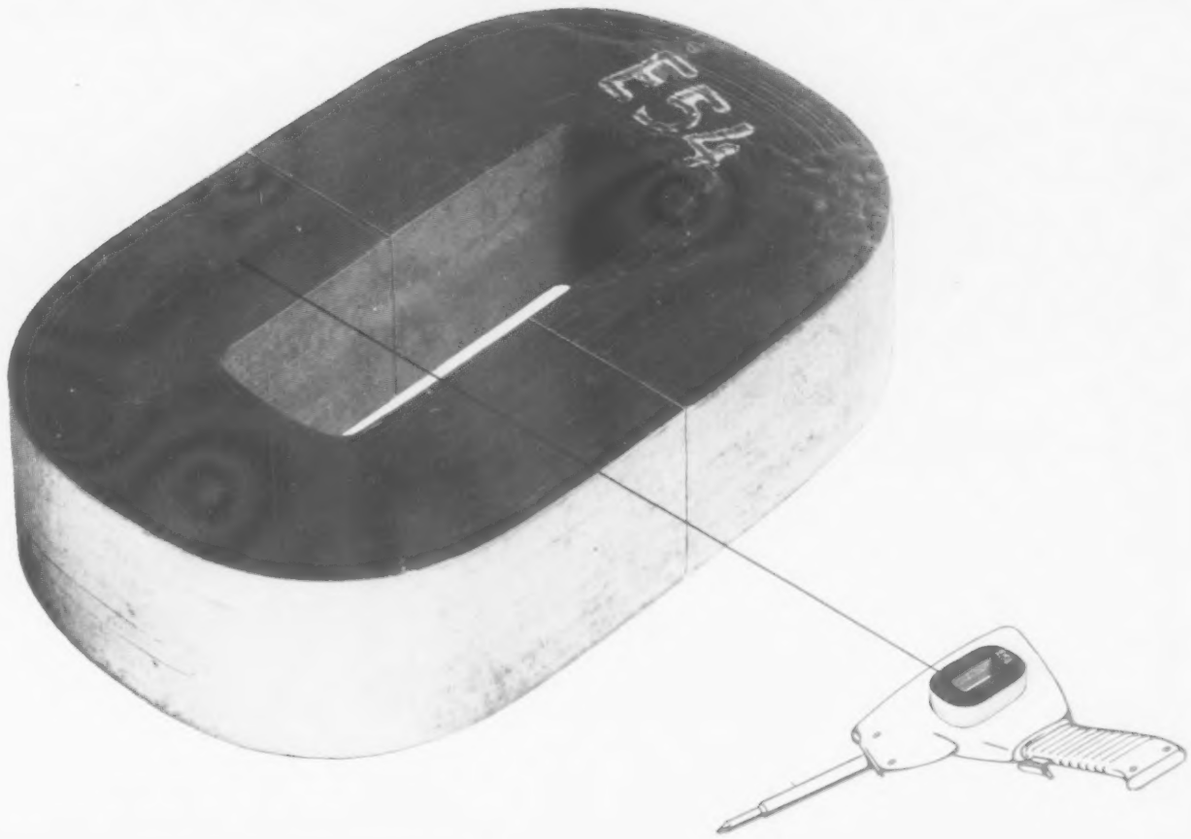

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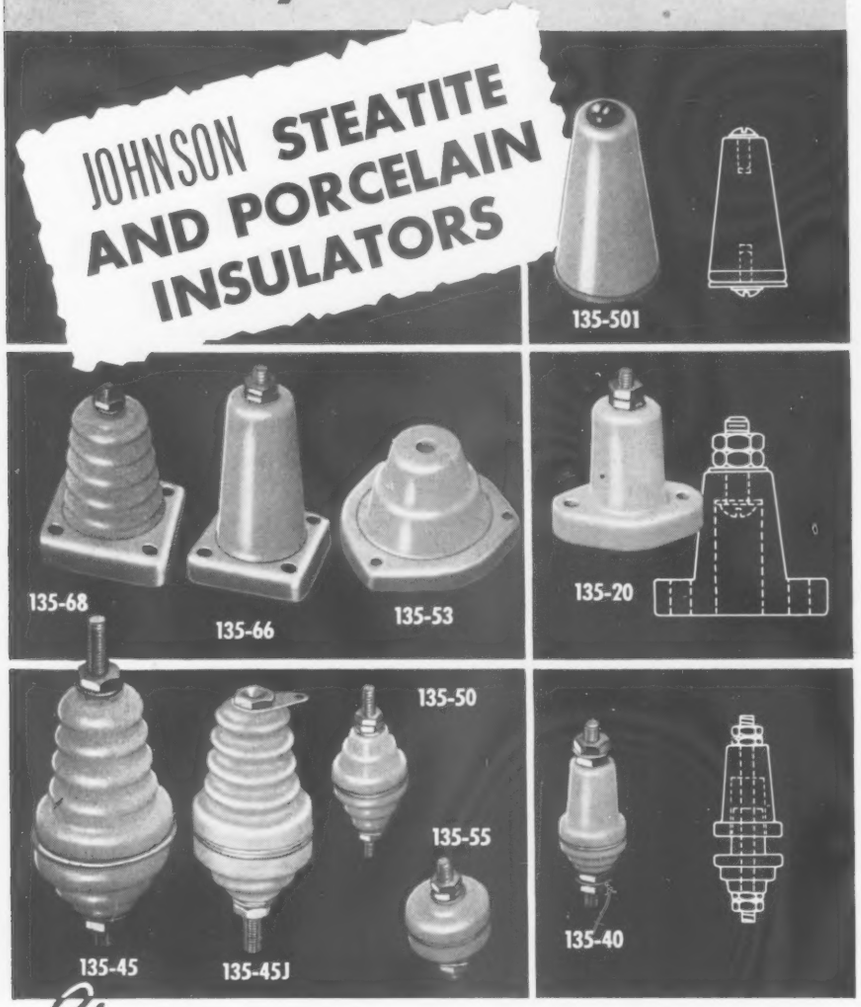

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the cascode[8] i-f tube in order to provide the proper impedance match with the desired 4½ MC i-f bandwidth. Figure 3 shows the sequence. The output impedance Z^1_2 at i-f of the crystal mixer is about 400 ohms and, therefore, the i-f coupling transformer design to match into Z_1 can be readily completed. Next, the input impedance Z_3 at radio frequency of the crystal mixer must be measured with the above network complete, so that the tuned circuits and high pass filter between the antenna and the mixer can be correctly matched. Then the best signal transfer from the atenna impedance Z_5 to the crystal mixer can be obtained.

The highest Q circuits consistent with the required 6 MC r-f channel width should be used so that the cross-modulation and image response are suitably reduced. The aim in controlling cross-modulation should be a reduction of 20 db in a signal located three or four channels away from the desired signal.

It is also important that the antenna be carefully matched to the transmission line in order to obtain the best overall noise factor. Any tube fluctuation noise transferred to the first tuned circuit together with thermal noise in this circuit can then be absorbed by the antenna (actually radiated) and avoid standing waves of input circuit noise at the first tuned circuit.

Thus far we have discussed some of the requirements of composite VHF and UHF receivers. Let us now consider UHF reception on standard VHF receivers.

Converter Design Considerations

Of necessity, a UHF converter must operate with a different intermediate frequency than that of the associated VHF receiver, otherwise it would be necessary to make actual wiring changes in the VHF receiver.

Utilization of the double superheterodyne principle is forced upon all designers of UHF converter units in order that the output signal may operate into one of the standard VHF channels. The choice of the channel could be fairly broad extending from channel 2 to channel 13. This choice sets the frequency of the pre-i-f amplifier which amplifier is also necessary to provide separation between the UHF mixer and the VHF receiver.

It has been found that there is an optimum range of frequencies for this pre-i-f amplifier. The frequency must be less than ⅓ of the lowest UHF channel, or, as pointed out by Yuan Pan,[10] the spurious responses

(*Continued on page* 110)

From the world's largest manufacturer of precision potentiometers . . . **Helipot**

come to Helipot *for the largest selection of* multi-turn *precision potentiometers*

advanced engineering! volume production!

HELIPOT is the organization that originated the helical potentiometer—the device that brought to electronic engineering new horizons of precise control by its greater resolution, higher linearity, mechanical precision, and broad range of resistance values. HELIPOT's policy of constantly working to anticipate the needs of the industry has led to steady advancement in the basic multi-turn principle—and today, HELIPOTS are available in the industry's widest selection of ranges and designs to meet varying requirements.

HELIPOT offers you . . .

▶ **Advanced Engineering.** Through its years of leadership HELIPOT has built an organization unequalled in the industry—with trained engineers, specially-designed equipment, overall facilities to solve *tough* potentiometer problems.

▶ **Volume Production of Special Designs.** HELIPOT not only welcomes tough potentiometer problems, but also has expanded facilities to mass-produce special designs to rigid specifications—at economical cost!

▶ **Versatile Basic Designs.** Most of the basic units shown below can be readily adapted to special requirements—ganged assemblies, servo mountings, single or double shaft extensions, taps spot-welded to a *single* turn of winding at virtually any desired point, and many other individualized features to meet *your particular needs!*

Illustrated below are typical basic models of Multi-Turn Helipots . . .

MODEL A:
A 10-turn unit, approximately 1¾" diameter with 12 to 14 times the resolution of single-turn units of same diameter. Very versatile—low in price—wide range of applications.*

MODEL C:
Similar to Model A, but 3 turns of resistance winding instead of 10.*

MODELS B, D, & E:
Larger-diameter (3 5/16") designs. B has 15 turns—D, 25 turns—E, 40 turns, for applications requiring extreme ranges of adjustment and highest possible resolution.*

ultra-precision

MODELS AN, BS, BSP, & CN:
Similar to Models A, B & C in size and performance but feature precision ball-bearings and extra-close tolerances throughout. Have approximately twice the linearity accuracy of equivalent standard Helipots—are ideal servo units.*

miniature

MODELS AJ, AJS, AJSP:
Tiny multi-turn Helipots the diameter of a penny, weight 1 oz. All have 18.5" slide wire for high resolution (1/6550—50 K unit). AJ has threaded bushings, sleeve bearings . . . AJS, servo mountings, sleeve bearings . . . AJSP, servo mountings, ball bearings. Many other features.*

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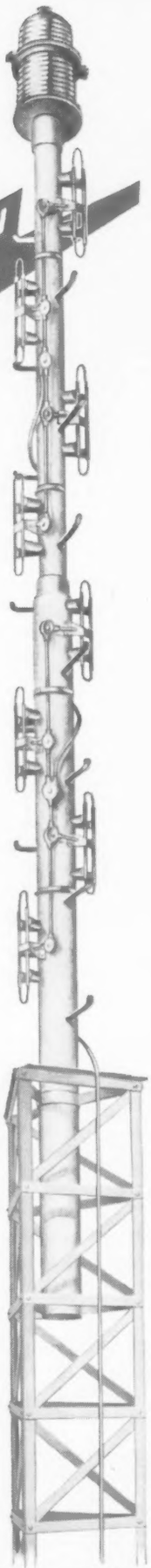
"HELIPOT" —T. M. REG.

high gain
LOW COST

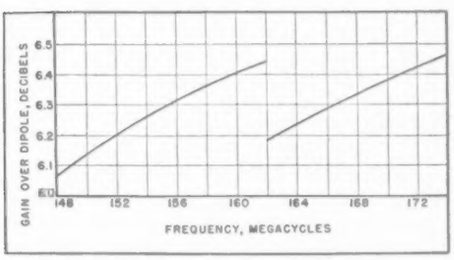


Andrew Omnidirectional Antenna for VHF Communications

No, this new High Gain Communications Antenna isn't cheap, but it does offer the most economical solution to your coverage problem. Whether you want maximum coverage for a specific transmitter power, minimum power or shortest tower for a specific coverage, or freedom from dead spots, the ANDREW Type 3000 Antenna is the least expensive solution. Why? Because talk-back is the limiting factor in mobile communications. Gain in the central station antenna costs less than increased power in every mobile unit.

ANDREW Type 3000 High Gain Communications Antenna offers better than 6 db gain in the 148-174 MCS band. This means that the power delivered to the receiver on both talk-out and talk-back is increased four times. The horizontal radiation pattern is circular.

Write for the ANDREW High Gain Antenna bulletin today!



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from harmonics of the local oscillator can be quite serious. This places the maximum usable i-f frequency below channel 7, and, for the vast majority of conventional VHF receivers, leaves the highest frequency choice as channels 5 or 6, or 76 to 88 MC. As you know, it is necessary to have a choice of two channels so that in a given location, the VHF receiver may be switched to the one, either 5 or 6, which has the lowest VHF interference.

In the design of the *tuner* section of a converter, the possible tuning arrangements are the same as in combination U and V receivers, such as continuous tuning and selector switching. However, the local oscillator must operate on a different frequency from that of a complete receiver, since the output of the converter must have the sound and picture frequencies in the same relative position as broadcast. That is, the sound frequency must be higher than the picture frequency in the pre-i-f amplifier. Therefore, the local oscillator in the converter must operate on the low side of the UHF incoming signal, e.g. on the highest channel, 884 to 890 MC, the local oscillator frequency is 802 MC when using channel 6 for the first i-f. One incidental result is a larger frequency ratio for the oscillator. In this example, 802 down to 388 MC. ($889.75 - 87.75 = 802$ MC and $475.75 - 87.75 = 388$ MC.)

Due to the simultaneous use of two local oscillators, one in the converter, the other in the VHF receiver, very careful shielding of the converter assembly is essential to reduce interference possible from the harmonics of one local oscillator beating with the harmonics of the other, together with harmonics of the intermediate frequencies. In addition, a high pass filter at the input to the tuner section and a low filter at the pre-i-f output of the converter are advisable.

1. R. R. Law, W. B. Whalley and R. P. Stone, R.C.A. Review, December 1948, page 643. G. H. Brown, J. Epstein and D. W. Peterson, R.C.A. Review, June 1948, page 177.
2. G. H. Brown, R.C.A. Review, December 1948, page 565.
3. W. B. Whalley, "Simplification of Television Receivers," Sylvania Technologist, Vol. III, No. 1, pp. 9-12, January 1950, and IRE Proceedings, December 1950.
4. W. B. Whalley, C. Masucci, N. P. Salz, "An Analysis of the Germanium Diode as Video Detector," Sylvania Technologist, Vol. IV, No. 2, pp. 25-34, April 1951.
5. B. F. Tyson and J. G. Weissman, Electronics, October 1951; Sylvania Technologist, July 1951, page 50.
6. Robert Adler, Electronics, October 1951.
7. E. W. Herold and C. W. Mueller, Electronics, May 1949, page 76.
8. Henry Wallman, Alan B. MacNee and C. P. Gadsden, "A Low-Noise Amplifier," Proc. I.R.E., Vil. 36, No. 6, June 1948.
9. D. O. North, RCA Review, October 1940.
10. W. Y. Pan, RCA Review, September 1950, page 381.

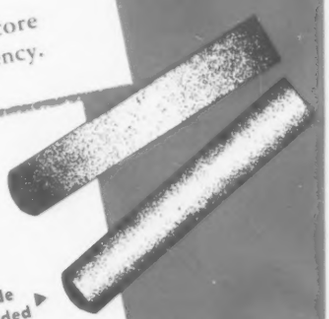
Are you missing any of these IRON CORE ENGINEERING POSSIBILITIES?

✔ **Smaller tuning units**
✔ **Less critical materials**

By providing electrostatic and electromagnetic protection over that supplied by the can, *Stackpole sleeve cores* permit use of a smaller can and enable it to be made from less critical and costly materials.

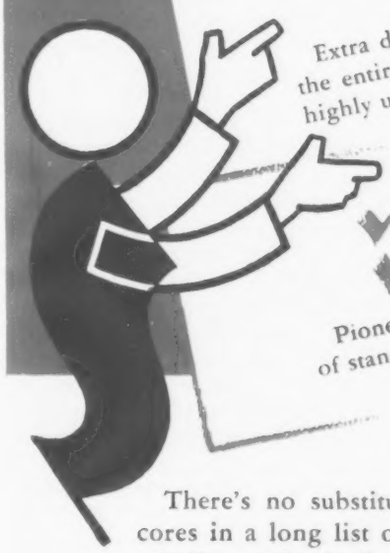
✔ **Higher Q**
✔ **Smaller assemblies**
✔ **Simplified tuning**

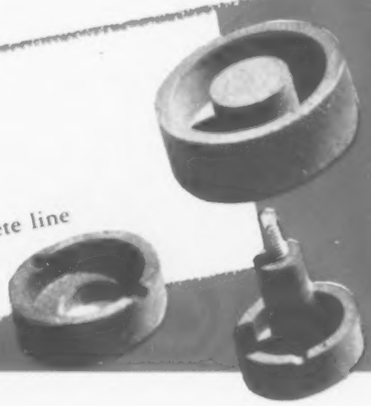
Stackpole threaded type iron cores eliminate the usual brass core screw from the field of the coil, thus greatly increasing efficiency.



✔ **Better, more accurate permeability tuning**

Extra density of molding pressure extends evenly over the entire length of *Stackpole side-molded cores* to assure highly uniform permeability.





✔ **No shielding problems**
✔ **High Q in small space**

Pioneers in *cup cores*, Stackpole offers a complete line of standard and special self-shielding types.

There's no substitute for molded iron cores in a long list of applications—electrically, mechanically or economically!

Besides all regular styles for high, low and standard frequencies, Stackpole offers full facilities for the quality-controlled production of almost any needed special type. Write for Catalog RC-8 to Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.

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Gray TELOP *(TELevision Optical Projector)*

Makes PROFITS GROW for TV Stations. The Gray Telop projects low-cost, easily produced TV 'commercials.' Without keystoning, any two photos, titles, slides, etc., or small objects may be broadcast with superimposition, lap dissolve or fade-out. Four optical openings. Strip material may be used horizontally or vertically with Stages #2 and #3. (For full details write for Bulletin T-101.)

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With the new, versatile Gray TELOP II you can produce an amazing variety of professional-quality commercials at low cost. TELOP II presents selling messages with opaque cards, photographs and transparencies. You get the effect of superimposition, lap-dissolve and fade-out. Only limitation is your imagination. One operator does it all! Write for full information on the new and exciting Gray TELOP II.

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Attaches to any optical openings of the Telop. Accommodates roll stock *vertically* to televise commentary or the commercial in the same way movie introductions are projected.

Gray STAGE #3

Attaches to optical openings of the Telop. News ticker tape fed from 8-mm reels is projected on any part of the screen, top to bottom, horizontally, may be used with test pattern or other commercial.

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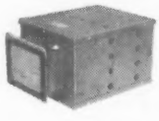

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For use where reversal is required. Designed to permit superimposing of the commercial or other copy.

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Enable a Single Camera to Serve up to 8 Projectors

Model 556 – Centered on a rugged 'square' pedestal, requires a minimum of space. Heavy duty ball bearings. Rotates 360°.

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Division of The GRAY MANUFACTURING COMPANY—Originators of the Gray Telephone Pay Station and the Gray Audograph and PhonAudograph

High Efficiency Coolers

(*Continued from page 71*)

4 per cent in volume on freezing). During solidification of the solder within the glass core in a test sample, a void was seen to form at the upper surface of the solder joint and then to extend longitudinally downward more than half the length of the core. The width of the void channel was about 10 per cent of the anode circumference. In addition, cross-sections of power tubes made with conventional coolers showed that 10

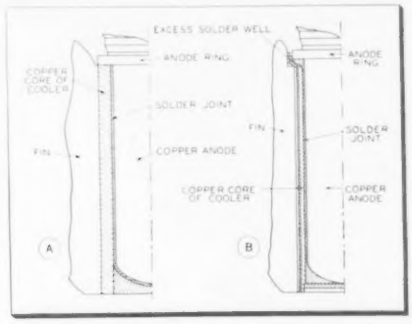

Fig. 7: (a) Initial copper core-anode-fin structure and (b) modified structure with solder well

to 20 per cent of the core area was not soldered to the anode.

The second source of trouble was observed when the test anode was inserted into the glass core at the start of the soldering operation. A layer of viscous flux residue normally floats on the molten solder in the core. When the anode is inserted into this liquid, a mixture of flux and solder is forced into the narrow passage between the anode and the core. Because of the high viscosity and surface tension of the flux residue, a relatively long time is required to allow the flux globules to rise to the top of the core via the very narrow clearance passage. On solidification, therefore, a quantity of corrosive flux residue having negligible heat conductivity is trapped in the critical area, particularly near the top of the cooler. This condition causes local overheating of the anode and destructive corrosion of the anode wall, and may result in early tube failure. The use of the excess-solder well, however, eliminates both faults. This well acts as an additional container into which the initial flux-rich solder is flushed, and out of which flux-free solder is supplied to the critical heat transfer area during solidification. Sections made of coolers employing the excess-solder well show the solder bond to be complete and without flaws in the thermally critical area.

1. I. E. Mouremtseff, "Water and Forced Air Cooling of Vacuum Tubes," Proc. I.R.E., Vol. 30, pp. 190-205; April 1942.

2. R. H. Norris, W. A. Spofford, "High-Performance Fins for Heat Transfer," Trans. ASME, Vol. 64, pp. 498-496; July 1942.

Sangamo's dry tubular electrolytic capacitor *that fits anywhere*

Type MT and MTD electrolytic capacitors, "Chieftains" of the Sangamo line, are built to provide longer life, greater dependability, and better electrical characteristics in television and other electronic applications. Their small physical size makes them a "natural" for application in tight spots beneath a chassis, and the bare tinned-copper wire leads make them easy to mount.

Sangamo "Chieftains" are contained in hermetically-sealed round aluminum cans and are tightly encased in heavy cardboard sleeves on which polarity is clearly indicated. Double, pure paper spacers assure adequate breakdown characteristics and all sections are tightly held in place within the container. Multiple staking connects the terminal tabs to the electrodes, providing permanent low resistance contact throughout the life of the capacitor. The low voltage units are supplied with etched cathodes to maintain uniform capacity when the capacitor is subjected to heat and high ripple currents.

"Chieftains" are manufactured under controlled conditions of almost surgical cleanliness, utilizing the very finest materials and production procedures available in the industry, for your assurance of quality in every respect.

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Warrior

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Your own trial-use will convince you that new standards of dependability and longevity have been built into Sangamo Electrolytics. Order from the new Sangamo Capacitor Catalog No. 800A which is yours for the asking, and without obligation.

Those who know — The SANGAMO Tribe — PAPER·MICA·SILVER·ELECTROLYTIC CAPACITORS — *...choose Sangamo*

SANGAMO ELECTRIC COMPANY

MARION, ILLINOIS

Direct Frequency

(*Continued from page* 63)

ranges as high as 4:1. With temperature compensation in sealed units, accuracy can be as high as 1 part in 10^5. With tunable units, accuracies have as yet been limited to about 0.01%. Frequencies from 200 to 60,000 CPS, a range of 300:1, have been covered by separate units.

Frequency Meters

Calibrated Electric Circuits: Units operating on this principle are not inherently capable of high accuracy since a relatively large number of components must be standardized. However, their low cost and simplicity are major advantages, and extremely sensitive null indicators can be used. Automatic systems need not be complex.

A Wien-Bridge Frequency Meter has been described having a frequency range from 25 to 10,000 CPS, or 400 : 1. A manually tuned dial is used to vary two gauged resistances in the bridge. Either a simple current instrument or a vacuum tube null detector may be used as the indicator. By choice of suitable components, an overall accuracy of 1% might be obtained.

The manually operated Parallel T Frequency Meter may be constructed using three gauged resistances and three fixed capacitors. The overall accuracy is probably limited to about 1% by component stability. An external null indicator is required.

Frequency to Amplitude Conversion

Conversion to Amplitude Measurements: Since errors due to these methods are the sum of those occurring in conversion from frequency to amplitude and those incurred in normal amplitude measurements, the systems will be most useful in instrument communications where very poor channel facilities exist. They have the advantage of being essentially fast response, direct reading, and relatively straightforward.

In the Hard-Tube Capacitance Frequency Meter, two vacuum tubes are used to charge and discharge a capacitor on alternate half cycles. The discharge current is measured directly by a milliammeter which can be calibrated in CPS. Useful range is from about 20 to 5000 CPS, about 250:1, and accuracy is on the order of 0.5%. This circuit can probably be improved.

The Gas-Tube Capacitance Frequency Meter employs two gas tubes and two diodes and uses a microam-

(*Continued on page* 116)

Jackson TELEVISION

Channels 63% Savings

WITH TINNERMAN SPEED NUTS®

● Engineers at Jackson Industries, Inc., Chicago, Ill. are "on the beam" when it comes to maintaining TV quality at production line speeds. They found the SPEED NUT way of attaching their new Tri-Lok television chassis to the cabinet picked up a neat 63% production savings! This attachment was one of their toughest fastening problems . . . to solve it Jackson found a standard Tinnerman part tailor-made and engineered for the job!

Four angle brackets are used to fasten the chassis to the cabinet. In the old way, an angle bracket was threaded to receive a machine screw, and it was necessary to align the screws perfectly with the threaded holes since the attachment is in a "blind" position.

SPEED NUTS eliminate the tapping operation required in threading the angle brackets, making hole alignment easier, faster! Now Jackson has adapted this part into their standards along with a 63% savings in time and materials-handling!

You can turn your fastening problems into production savings . . . do as thousands of manufacturers are doing . . . turn to Tinnerman for a FREE FASTENING ANALYSIS of your products. The Tinnerman representative in your area will be happy to give you the full details on this great service. Call on him today or write direct to: TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio.

In Canada: Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S.A.—7 rue Henry Barbusse, Levallois (Seine.)

THE OLD WAY:
The 4 angle brackets were drilled and tapped to receive machine screws in attaching the chassis to the cabinet; hole alignment was always a problem since brackets are in "blind" positions.
THE SPEED NUT WAY:
The SPEED NUT Principle of Spring Tension fastening applied to the 4 angle brackets eliminates these hole alignment problems providing sturdy, vibration-proof attachment.
TINNERMAN Speed Nuts®
FASTEST THING IN FASTENINGS®

Pick Up **Extra Profit**

Eliminate call backs with this really portable precision-made Cossor Oscilloscope. Take it with you on every call. The 1039 is easily carried, weighs only 9¼ pounds! Built for years of tough service. Metal control knobs. C.R. Tube mechanically protected. Recessed sockets giving access to X and Y plates, amplifier, synch and ground connections. High frequency amplifier in 2 ranges 25 C.P.S. to 3.5 MCS. Variable gain control. Separate switching provides DC to Y, AC to Y, signal to amplifier at maximum gain (60) or intermediate gain (10) . . . Repetitive time base 10 C.P.S. to 50 KCS. plus with negative synch. Finish—sage gray enamel. See your jobber or write for complete information.

Light • Fast
Rugged • Precise
Easy-to-Operate
5½" x 4½" x 11½"
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PORTABLE OSCILLOSCOPE

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meter to measure a fraction of the charging current through two capacitors in the cathode circuits of the gas tubes. Frequency range and accuracy are about the same as for the hard-tube frequency meter. Both of these meters are affected by the harmonic content of an input wave form.

The Vacuum-Tube Pulse Frequency Meter measures frequencies automatically by converting sine waves into constant voltage pulses which are allowed to charge a capacitor in the input circuit of a vacuum tube voltmeter. Thus, variable input frequency is actually converted to a variable voltage amplitude. Actual indication is on a linear scale microammeter. Typical frequency range is 25 to 60,000 CPS, or about 2400:1. Accuracy is about 2%. Conventional chart-recording instruments can be used with the meter.

Use of Discriminators

Discriminators are used in communications to convert variations in frequency directly to variations in amplitude. These circuits normally consist of a transformer, resistors, capacitors, and linear or square law rectifiers. One limitation of these devices has been the relatively narrow frequency ratio over which linear operation is possible; one recent analysis has shown substantial linearity over a range of about 1.3:1. Accuracy depends on component stability, and might be on the order of 1 to 5% with commercial parts.

Vibrating-String Discriminators may be used as a frequency selective filter, and the linear portion of its response curve can serve as a high stability discriminator. Since amplitude response is involved, accuracy may be estimated at 1%; however, further development work may prove this estimate too conservative. The frequency ratio obtainable will depend on stabilities obtainable with low Q units but may be as low as 1.1 : 1.

Conclusions

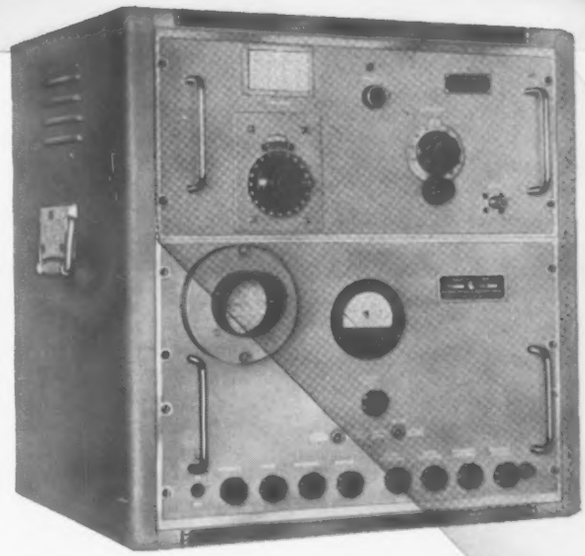
A few general conclusions may be drawn from the foregoing discussion, considering some of the data as presented in Figs. 4, 5 and 6.

Fig. 4 shows a rough comparison of some frequency and amplitude standards and meters. Many ingenious basic principles are represented, and many roads toward improvement exist. The major points of interest concern the greater accuracy of frequency systems.

Fig. 5, showing the approximate

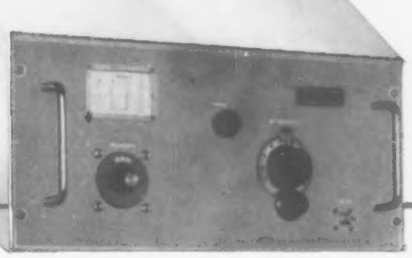
(*Continued on page* 118)

FOR X-BAND OR S-BAND



PRD TYPE 850 SERIES

universal spectrum analyzers



– WITH INTERCHANGEABLE R-F SECTIONS

There's no excuse for guess-work in r-f pulse analysis. PRD's spectrum analyzers provide the most up-to-date means for accurate determination of microwave spectra. The simple interchange of demountable r-f panels permits operation at either S- or X-band . . . or at other bands as additional r-f sections become available. Of particular importance is the versatile arrangement of the microwave components, making possible the independent use of the variable attenuator, frequency meter, mixer, and local oscillator for a variety of bench measurements.

- ACCURATE R-F PULSE ANALYSIS
- RADAR SYSTEM OSCILLATOR ADJUSTMENT
- DETERMINATION OF MAGNETRON PULLING AND AFC OPERATION
- WEAK SIGNAL DETECTION
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GLOBAL MICROWAVE

(*Continued from page* 41)

coincides with the shortest eastern bombing route from the Soviet Union to the U. S.—highlighting the air-warning service which can be readily included. It is no wonder that industry leaders, the North Atlantic Treaty Organization and U. S. Government officials are seriously considering this plan. (See Aug. TELE-TECH, p. 33; also Oct. 1952, p. 66 et seq.) On April 14, 1952 it was officially presented to representatives of the State Dept., Defense Dept., FCC and National Bureau of Standards. Sen. Karl Mundt, co-author of the act establishing the Voice of America, has said that groundwork had already been done to "provide a financial set-up to implement this program."

It is conceivable that in five years a U. S.-Europe-Near East Network can be placed in operation—a significant step in the unification of the free people of the world. Eventually, UNITEL could be extended to cover South America, Africa, Scandinavia, and other areas shown in Fig. 1.

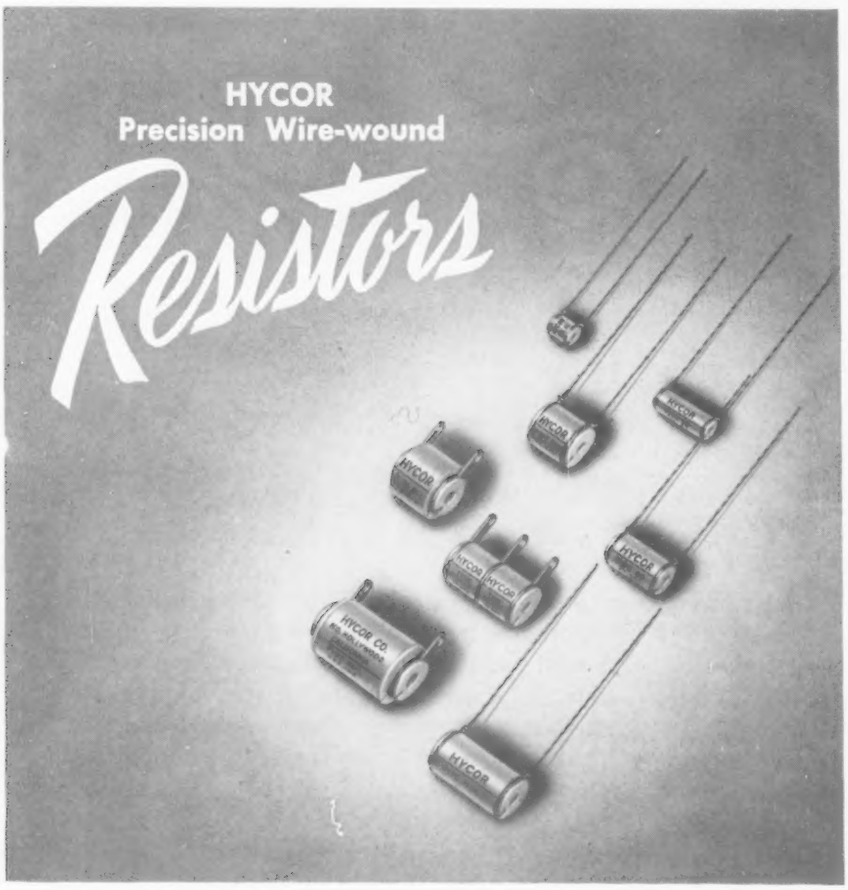
Differences in TV standards are not considered an imposing obstacle. As was shown in Paris-to-London telecasts, scanning rate conversions may be accomplished, but with some loss in picture quality. Present audio and video recording techniques are adequate to take care of any rebroadcasts necessitated by time differences around the world. A suitable system of video recording on magnetic tape will be an even greater aid. Ultimately, it is hoped that a single international standard will be adopted.

Finances

The cost of this monumental undertaking is impressively high, but not insuperable. According to UNITEL's planners, the basic mountaintop regional TV and FM broadcast equipment can be installed for about $250,000. An additional service such as multi-channel microwave would add $25,000 to this figure. Existing commercial equipment for an unattended microwave relay station should run close to $70,000. The estimate for the entire technical set-up for the Japanese Network is $5,500,000. Similar installations for countries the size of Turkey or Egypt should cost under $10,000,000. The bill for the trans-Atlantic NARCOM system has been estimated as $50,000,000 to $100,000,000, or about the cost of one large ocean liner.

Raising the necessary funds will require perseverance, and more important, a program of informing government and industrial leaders of

(*Continued on page* 122)



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Skilled, painstaking attention to EVERY detail in EVERY step of fabrication!

Our steady customers tell us that the formula works!

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Direct Frequency

(*Continued from page* 116)

time required for measurements having various accuracies, is significant. Galvanometers and electromechanical voltmeters, as well as the vibrating-reed frequency meter, are limited in response time by their mechanical features. Manually operated devices are obviously slow. The events-per-unit-time meter and similar systems are potentially capable of higher accuracy and higher speed than presently available through use of better crystals and arbitrarily shorter time intervals.

Fig. 6 shows the approximate space required for various measurement accuracies. Since the frequency systems high on the graph are essentially narrowband devices, it is clear that a need exists for a small, relatively simple frequency meter analogous to a voltmeter. The need for better standards of amplitude measurement has already been mentioned.

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Max. RMS Applied Voltage....26 volts
Max. RMS Input Current.....500 *ua*
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Reverse Current at 10 V RMS...0.6 *ua*
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Max. Average Rectified Current..1.5 ma
Peak Rectified Current.....20 ma
Max. Surge Current (1 sec).....80 ma
Ambient Temp. Range..−50 to 100° C
Max. RMS Applied Voltage....26 volts
Max. RMS Input Current.....3.75 ma
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E-C GLASS RESISTORS

(*Continued from page 55*)

temperature coefficients of less than 30 ppm/°C. The voltage coefficient is also small—10 ppm/v. or less.

E-C glass resistors are highly resistant to moisture attack. The base resistive element without any protective covering was not affected by 250-hour exposure to 95-100% relative humidity at 40°C. The resistance change induced by this treatment was less than 0.5%.

These thin film resistors have excellent high frequency characteristics. Measurements of effective resistance at 200 and 400 MC made on a limited number of resistors by the Components and Materials Branch of Squier Signal Lab. indicate that the high frequency properties of these resistors are at least equivalent to those of characteristics proposed for VHF resistors in ASE SA Project #331.

Facilities for mass production of ½, 1, and 2-watt E-C resistors are being set up by Corning under an Industrial Mobilization Contract with the Bureau of Ships. Dimensions, resistance range and power ratings for typical resistors are shown in Table I. The ½, 1, and 2-watt power ratings are at 120°C ambient (i.e., approximately 200°C operating temperature). When operated down at the conventional ambient of 40°C, these power ratings can be doubled. The maximum resistance values attainable at the present time in these three sizes are 10,000, 40,000 and 100,000 ohms, respectively.

Fig. 4: Comparison of glass and wire-wound resistors shows small size of the glass type

New Line Being Developed

A line of E-C glass power resistors is being developed at the request of the Signal Corps Engineering Labs. One of the interesting aspects of these E-C power resistors is that high resistance values can be attained in relatively small physical size. This is shown in Fig. 4, where the size of the smallest 63,000 ohm JAN-R-26A wire-wound power resistor is compared with that of an E-C glass power resistor of the same resistance value. Other characteristics of E-C glass resistors of interest in power applications are their low inductance, good thermal shock resistance, and the large possible savings of critical materials normally used in resistance wire.

Table II shows approximate dimensions, power ratings, and resistance values of typical E-C power resistors.

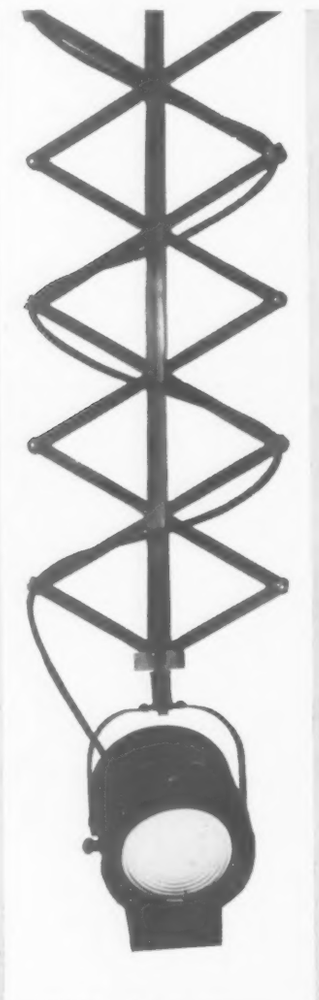
Special Types

Special types of air-cooled and water-cooled units with power ratings into the kilowatt range are finding increasing application as dummy-load resistors. Good stability and high-frequency characteristics are primarily responsible for their use in these applications.

To summarize, it is believed that the development of E-C glass resistors is a significant step in the direction of higher quality electronic components.

This paper was first presented at the AIEE-IRE-RTMA Symposium on Progress in Quality Electronic Components, May 5-7, 1952, Washington, D. C.

Balanced, floating, overhead suspension is what you get with a Century LITELIFT . . . No more climbing ladders to relamp, refocus or change angle—just pull the light down to you and then push it back to where you want it . . . The LITELIFT does all the work . . . No more tangled cable on the floor — the LITELIFT holds it neatly out of the way



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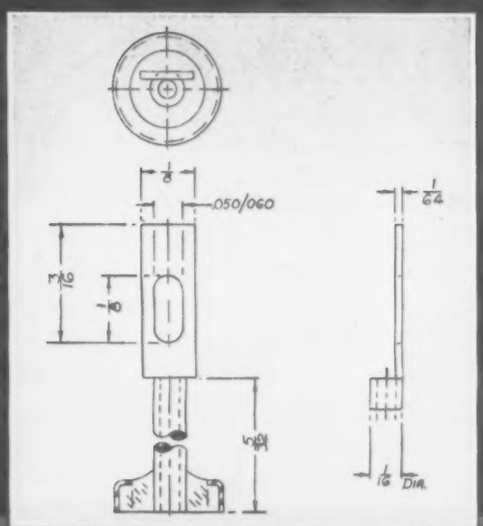

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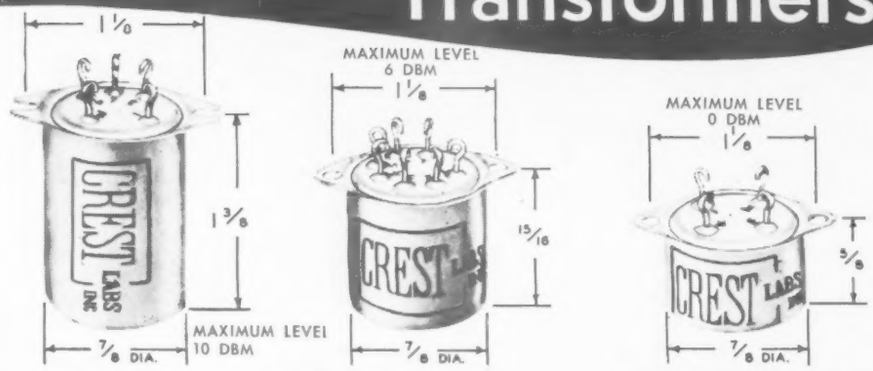

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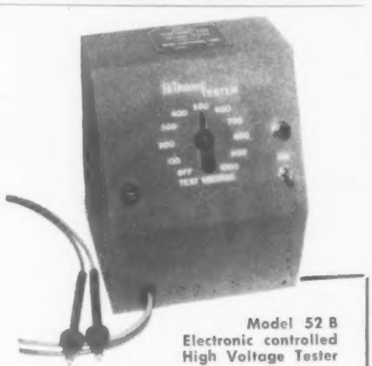

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Manufacturers of Electronic Test Equipment

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(*Continued from page* 118)

the manifold advantages of a unified telecommunications network. Wherever possible, capital should be obtained from private sources, as was done in Japan. Grants to underdeveloped countries may be made by the United Nations, as they did in Afghanistan. For projects such as NARCOM, the obvious military applications should encourage NATO to initiate construction. And in other countries, loans from international banking sources or subsidies from the U. S. through the Mutual Security Agency may be sought.

UNITEL is a logical step in the technological trend of forging one world containing free men who understand one another. UNITEL means a bolstered defense against Soviet aggression. It means opening new markets to American industry. The need is critical. The time is now.

Subminiature Amplifier

(*Continued from page* 47)

for amplifiers that will operate satisfactorily at temperatures of 200° F. or above, the type of glass used in tube envelopes becomes important. At least one tube manufacturer is already supplying all premium subminiature tubes with hard glass envelopes. These have a maximum bulb temperature rating of 482° F. The life expectancy for these tubes, when operated within ratings and with a bulb temperature of 392° F., is 1000 hours. When operated with a bulb temperature of 176° F., the life expectancy is 5000 hours.

Reliability Key Objective

Work is continuing on the miniaturization of equipment, with reliability remaining the key objective. An effort is being made to establish the best balance between minimum size of designs versus their versatile use in similar systems, so that fewer varieties of spares are required for stocking by the military. Progress is being made on the miniaturization of transformers and improvement of their application in high temperature amplifiers. Studies are being made of the application of transistors and of the use of hybrid electronic-magnetic amplifiers to our systems. New methods are being applied to hermetically sealed enclosures. Because miniaturization is such an extensive and important effort to the aircraft industry, a considerable amount of our engineering manpower is being used on these problems.

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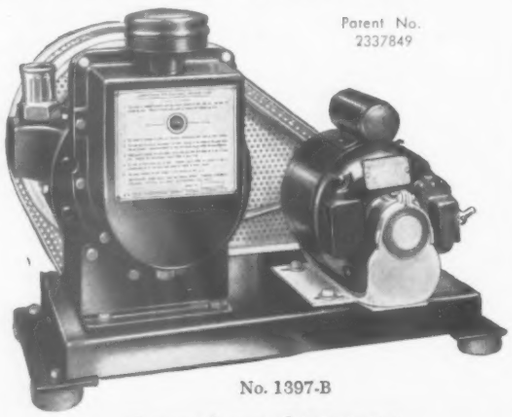

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Phase Shift

(*Continued from page 39*)

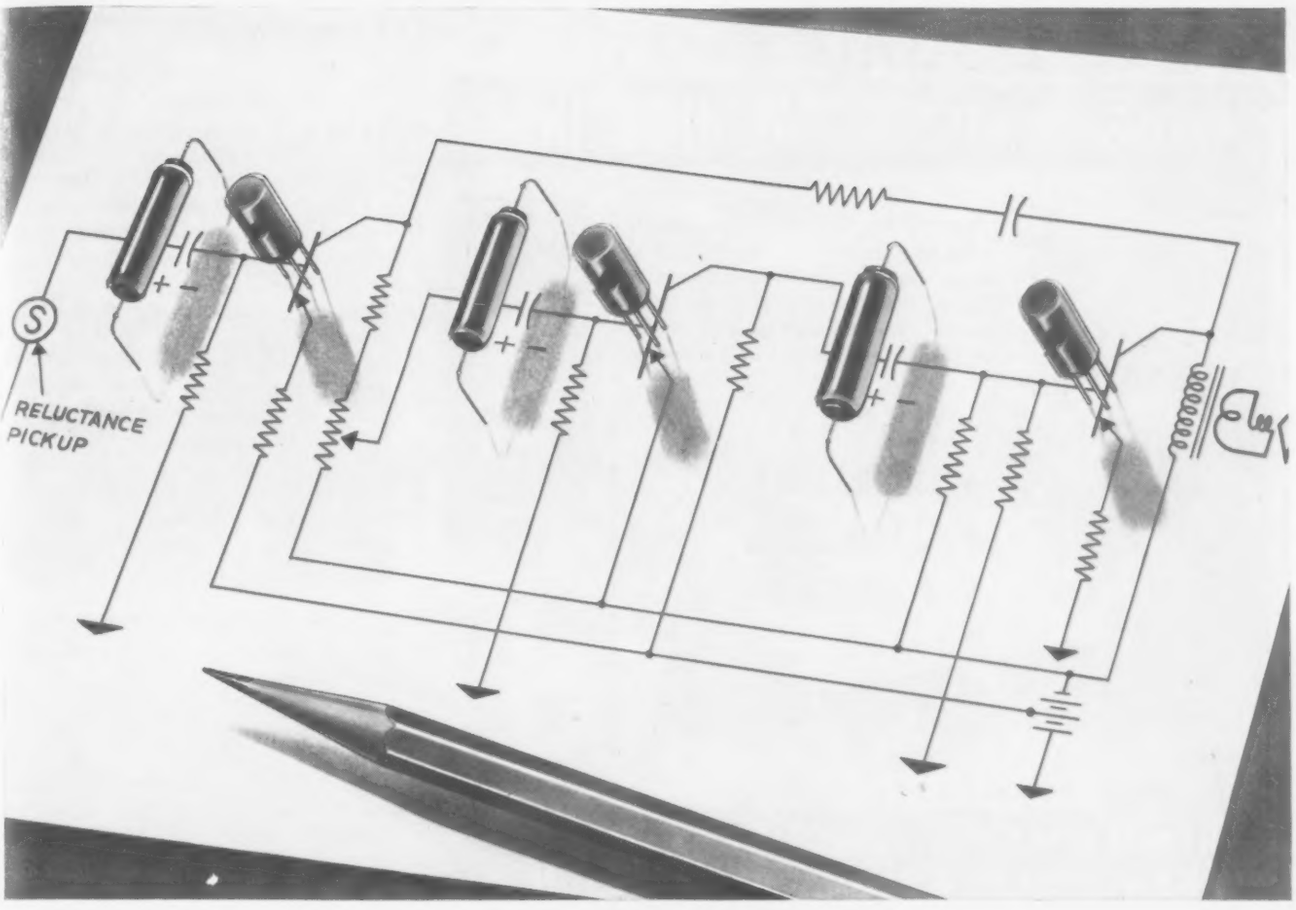
crt face. The vertical signal is now placed through an appropriate attenuator, through the unit to be tested, and from there into the vertical deflection circuit of the oscilloscope. For $n = 1$, the arrangement of Fig. 3a results.

With phase shift at the test frequency we will now get a pattern in which the crossover points are displaced from those of the reference conditions. Measurement of the displacement measures the phase shift. That is, $a\text{-}a'/a\text{-}b = \sin\theta/\sin(360/2n)$ in Fig. 2. Where the angles are sufficiently small $\sin\theta = \theta$, so $a\text{-}a'/a\text{-}b = 360/2n$. There is still an ambiguity, since the same pattern will be seen with 30, 75, 120, ... 345°. This is quickly resolved by means of a coarse measurement using a value of 1 for n.

For work with small phase shifts, it is highly satisfactory to use a value of 12 for n. This makes the distance between adjacent crossover points 15°, and assures a linear relationship between phase shift and displacement. Since 15° occupies the same space on the scope that 180° does when $n = 1$, the accuracy of reading is increased by a factor of 12.

The technique described here is quite satisfactory for use in the audio frequency range. For work above this range, considering the frequency response of typical horizontal deflection amplifiers used in oscilloscopes, it is necessary to apply the higher frequency to the vertical deflection amplifier. The suggested upper frequency limit for this measurement system is 50 KC for the horizontal signal and 1 MC for the vertical. However, it should be noted that the test set-up has been used successfully up to 250 KC and 3.5 MC, for the horizontal and vertical, respectively.

For laboratory use, separate oscillators (Fig. 3b) are the simplest solution. In general, a two-hour warm-up period makes the drift of one oscillator with respect to the other a negligible problem. For production line use, however, where only a small number of spot frequencies are to be checked, the use of more elaborate equipment such as single frequency oscillators and frequency multipliers, may well be warranted. See Fig. 3c. Alternatively, some means might be employed to synchronize one oscillator at a subharmonic of the other. This could easily be done by means of a countdown circuit, the output of which is used to synchronize the second oscillator.



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Although still experimental, this 3-stage amplifier promises significant advances in miniaturized equipments. It has a power output of 100 milliwatts—less than 10% distortion—and a power gain of 70 db.

Tantalytic capacitors were a "natural" for interstage coupling in the circuit because of their small size, large capacitance and low leakage current. They match the transistors in ruggedness and long operating life. And they will operate over a wide temperature range (−55°C to +85°C with at least 65% capacitance at −55°C). Other features include light weight, long shelf life, and hermetic sealing.

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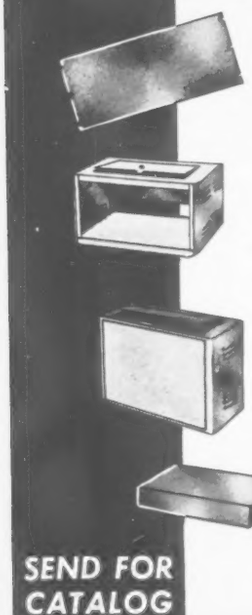

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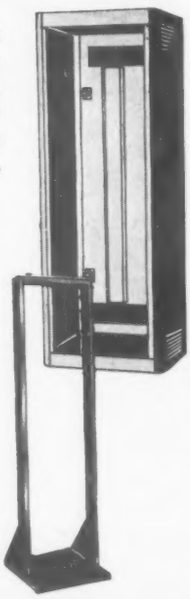

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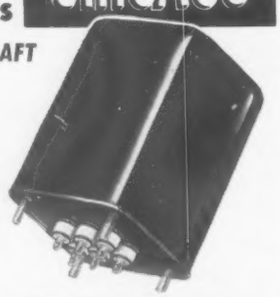

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Loop Antenna

(*Continued from page* 44)

The swr vs. frequency of a 12-loop antenna for channel 11 is given in Fig. 12. The swr is less than 1.1 over the required band, and is less than 1.2 between 187 and 208 MC, which indicates that the matching of the antenna is not critical. The azimuth

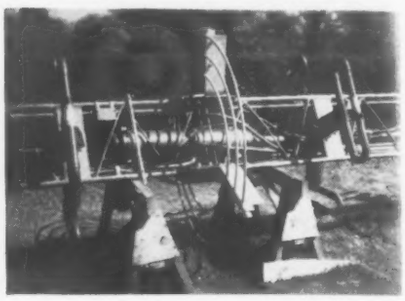


Fig. 10: Isolating ring and balun

pattern, shown in Fig. 13, is omnidirectional within ±½ db.

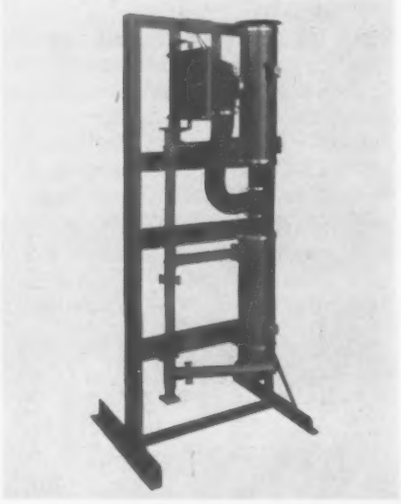
The 16-loop antenna in Fig. 1 will safely handle the transmitter powers required to produce an ERP up to 316 kw. The only change required in the 12-loop antenna is to substitute RG-19/U cable for the RG-17/U cables or to use teflon insulated RG-17/U cables.

Close-in Coverage

It is sometimes stated that most of the difficulties encountered in receiving a satisfactory signal within a mile or so of the transmitting antenna are due to the fact that this region receives power from the side lobes of the high gain antenna. In an urban area it is difficult to separate the effect of reflections from many buildings from the effect, if any, of the pattern of the antenna. Fig. 14 shows a calculated close-in coverage

(*Continued on page* 128)

Fig. 11: Photograph of television diplexer unit



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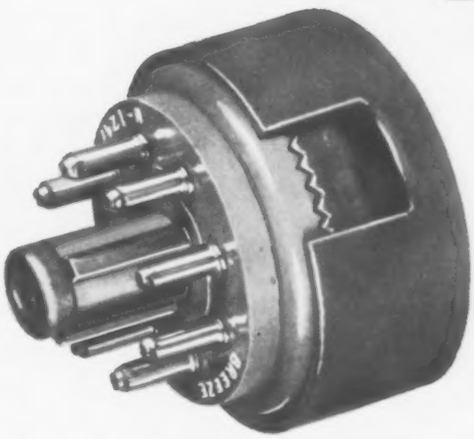

Battery Connectors

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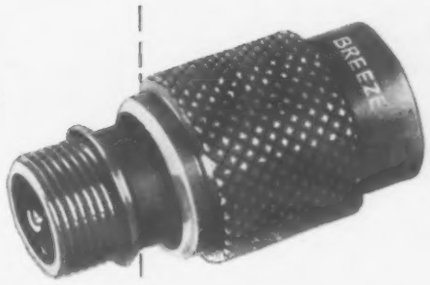
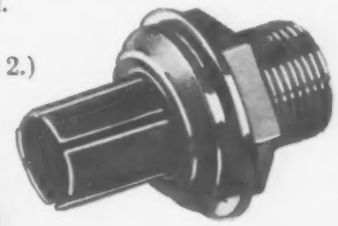
Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP – 416, Type 2.)





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for a 16-loop array with 18.5 kw of transmitted power as compared to the same power into a half-wave dipole. It can be seen that there is a very high field strength in the immediate vicinity of the theoretical nulls of the antenna pattern. Hieh[illegible]

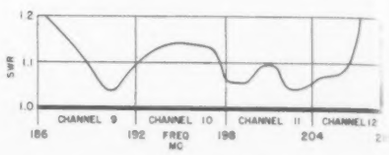


Fig. 12: SWR of 12-loop antenna for channel 11

has shown that for a 12-bay antenna 500 ft. above ground that the field strength is high at distances as close as 200 ft. from the antenna base. For very high (a mile or more) antennas, the antenna can be phased to tilt the beam. This may easily be accomplished, by successively advancing

(*Continued on page* 130)

Fig. 13: Horizontal radiation pattern of the loop antenna is omnidirectional within ±0.5 db

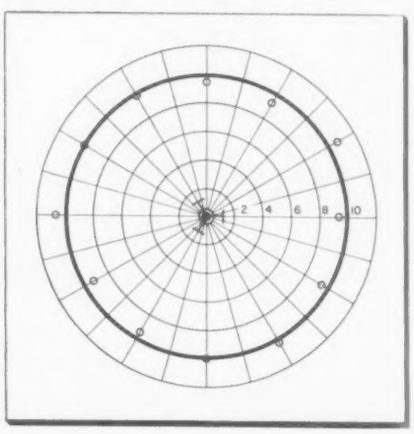
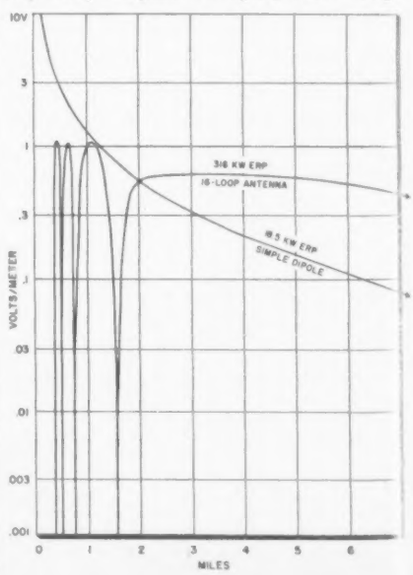


Fig. 14: Calculated close-in coverage of 16-loop array compared to dipole; 500-ft. height



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	WL-6102 Oil Immersed	WL-6103 Air Cooled
Peak Inverse Voltage	40 KV.	20 KV.
Peak Current	900 MA.	900 MA.
Average Current	150 MA.	150 MA.
Filament Voltage	5.25 V. (5.0 V. Center)	5.25 V. (5.0 V. Center)
Filament Current	7.6 AMP. (7.2 AMP. Center)	7.6 AMP. (7.2 AMP. Center)
Height	2-13/16 IN.	2-15/16 IN.
Diameter	2-1/16 IN.	2-1/16 IN.
Weight	3½ OZ.	8½ OZ.

Typical Operation

	WL-6102	WL-6103
Single Phase, Full-Wave		
Full Transformer Secondary Voltage (RMS)	28,300 V.	14,100 V.
DC Output Voltage to Filter	12,700 V.	6,300 V.
DC Output Current	.300 AMP.	.300 AMP.
3-Phase, Half-Wave		
Transformer Secondary Voltage (RMS)	16,400 V.	8,200 V.
DC Output Voltage to Filter	19,100 V.	9,500 V.
DC Output Current	.450 AMP.	.300 AMP.

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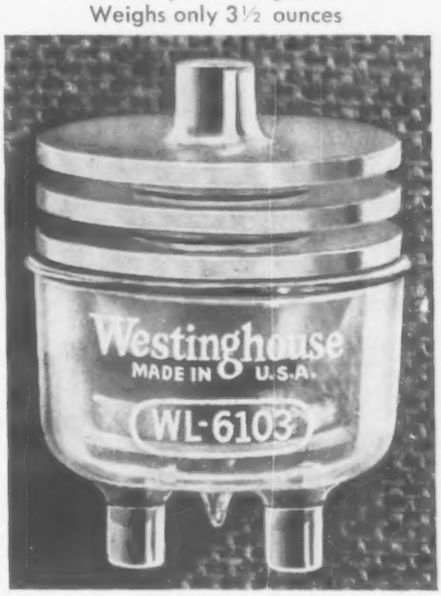

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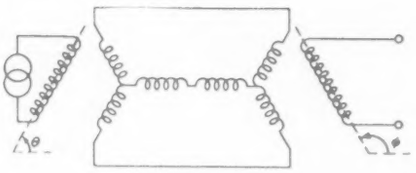

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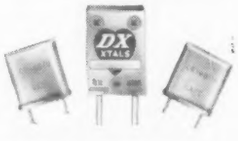

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the phase of loops with height[3]. This is convenient to do for the feeder to each loop in the array is a matched 50 ohm line.

Changing Minima

The minima can be filled by changing the phase of one loop. If the antenna has an odd number of radiators, changing the phase of the center radiator by ± 90° eliminates all nulls because the field from this radiator is always in quadrature with the field from the other radiators. If the antenna has an even number of radiators, changing the phase of one radiator near the center ±90° also fills in the nulls, but less completely than with an odd number of radiators. For all practical purposes the results are the same. Fig. 15 shows the calculated[4] field strength for a 16-bay antenna 2000

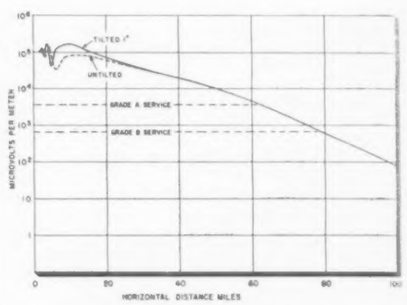

Fig. 15: Field strength of 16-loop array

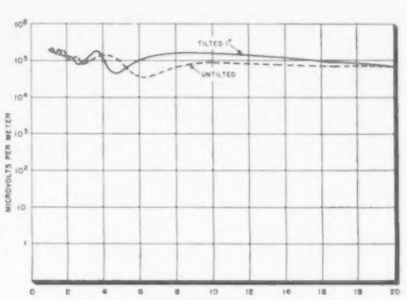

Fig. 16: Close-in field of the 16-loop array

ft. above ground with the beam tilted down 1° with the ninth loop from the bottom fed at +90° relative to the other loops. Grade A service (FCC definition—71 db above 1μv/m or 3.5 mv/m) extends beyond 60 mi. Grade B service (FCC definition—56 db above 1μv/m or 0.6 mv/m) extends out to 80 mi. Fig. 16 is an enlargement of Fig. 15 and shows the field strength at distances between 1 and 20 mi. Also shown on these figures are the field strengths when the beam is horizontal. By varying the angle of tilt it is possible to

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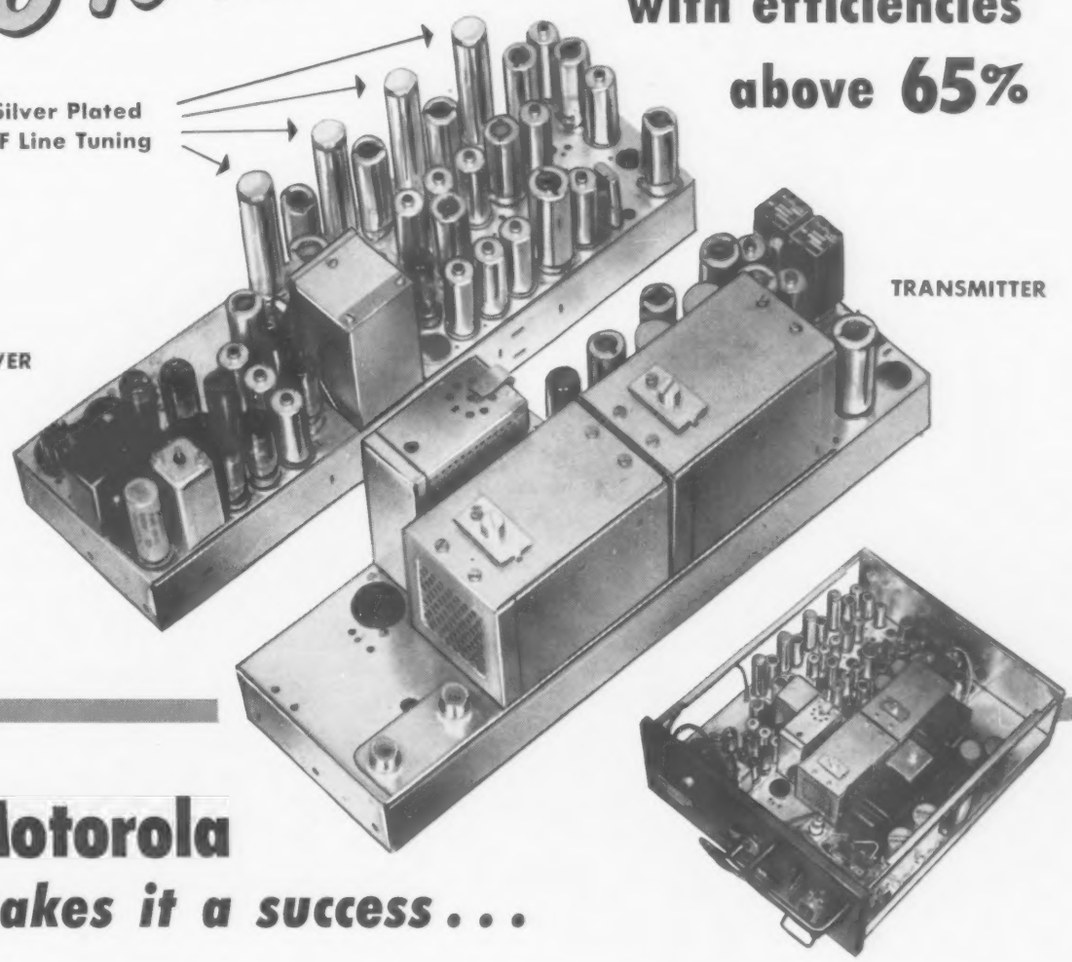

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favor some distances over others. On the above example the region between 5½ and 20 mi. gets more signal than if the beam were not tilted.

With this feeding arrangement the pattern is roughly "cosecant" (field strength independent of distance) out to about 20 mi. The gain is decreased only a few per cent so that high gain is retained for outlying areas where it is needed the most.

An 8-loop array for channel 7 has been installed and in operation in Buenos Aires since Sept., 1951. The overall swr from 174 to 180 MC was uder 1.1, and video and sound carrier swr were 1.05 and 1.07, respectively. The antenna is 450 ft. above ground, and good reception has been reported 140 mi. away.

1. A. G. Kandoian and R. A. Felsenheld, "Triangular High Band TV Loop Antenna System," Communications, pp. 16-18, August, 1949.

2. M. E. Hiehle, "Engineering a Super-Gain TV Antenna," Television Engineering, pp. 16-18, 27-28, May, 1951.

3. Kandoian, Sichak, and Felsenheld, "High Gain with Discone Antennas," PROC of the National Electronics Conference, Vol. 3, pp. 336-346, 1947. Reprinted in Electrical Communications, June, 1948.

4. Figure 6, Part II, "Estimated Field Strength exceeded at 50 per cent of the potential receiver locations for at least 50 per cent of the time at a receiving antenna height of 30 feet"—Sixth FCC Report and Order, FCC52-294, Released April 14, 1952.

TV Prompter

(*Continued from page 47*)

eyes would not be seen roaming back and forth.

The floor director operates it by turning the top handle at the proper speed to suit the announcer. The line being read is always kept opposite the pointer, located on the upper left hand corner, so he has no difficulty keeping his place.

The mounting brackets consist of two boxes, one fitting inside the other. The larger box mounts permanently on the pedestal, while the smaller one mounts permanently on the back of the prompter. The prompter is mounted by putting the two boxes together, a hole is drilled through both boxes on either side where a pin goes through holding it in place. In this way they can be changed from one to another or taken off completely in just a few seconds.

Because each announcer prepares his own copy for use it is advisable to have several prompters on hand. The copy can be prepared for the machine in a lot less time than it would take to memorize it.

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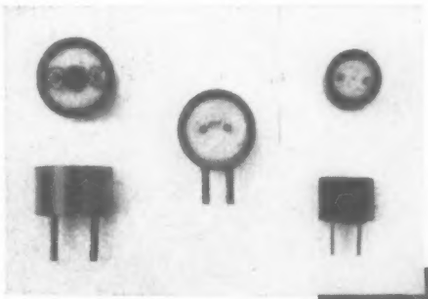

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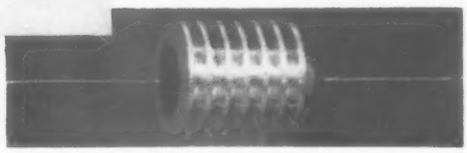

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Selenium RC

(Continued from page 59)

starts. Hence, for a known ripple frequency, the period of conduction can be related to the RC (time constant) of the load.

In Fig. 7, the degrees of conduction are plotted against RC of load for 60 cycles, full wave, giving a ripple frequency of $\frac{1}{120}$ second. The

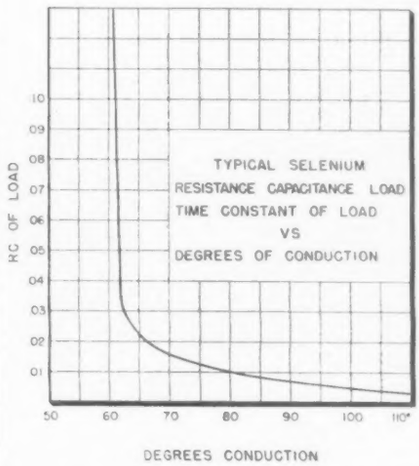


Fig. 7: Relation of RC to conduction period

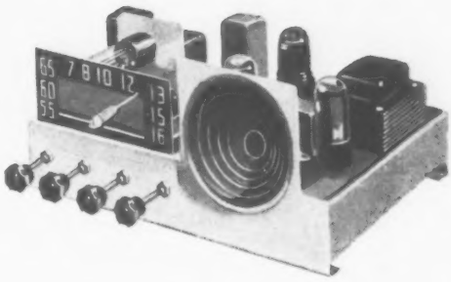
value of RC for any case is the product of load resistance in ohms and capacitance in farads. When the value of C approaches zero, conduction approaches 180°. For values of RC greater than 0.03 seconds, the change in conduction is very slight and does not appear to fall below 60° for any reasonable values of RC.

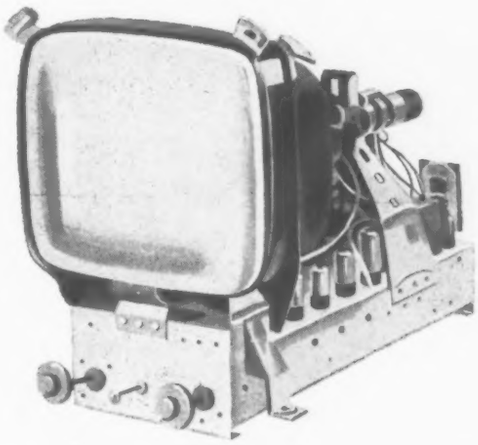
As stated, this particular curve applies only to full-wave, single phase operation from a 60 cycle source. However, it covers the situations most frequently encountered. Other curves would have to be derived for half-wave operation or for frequencies other than 60 cycles.

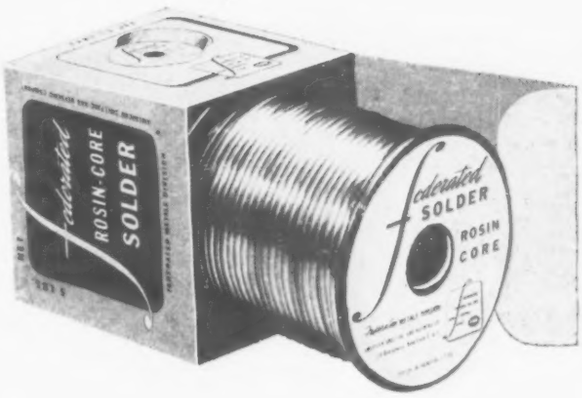
It should be emphasized that this entire discussion is based on steady state conditions and does not take into consideration the high transient currents occurring during the initial charging of the capacitor. This is a story within itself and not within the scope of this paper.

West Coast Audio Fair Feb. 5-7, 1953

"The Audio Fair—West Coast" is being planned for Feb. 5, 6 and 7, next year, at one of the large Los Angeles hotels, with operating exhibits in individual suites all on one floor. W. L. Cara, 4245 Normal Ave., Hollywood 29, Cal., has been appointed manager of the fair, and will be assisted by a six-man committee comprising two distributors, two representatives, and two manufacturers.

FOR RADIO  AND

TV  SOLDERING THAT LASTS...

USE... 

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Binaural Sound

(*Continued from page* 50)

is made not in the 12-in. size, but as a 10-in. disc, where the diameter of start of the test grooves corresponds closely to a zero point in the radial error cycle.

No better method than cut-and-try has been discovered yet for cutter alignment on the recording lathe, and such alignment then has to be done in conjunction with a playback turntable whose adjustment has been made on the basis of the Series 30 record as a standard.

The difference in frequency response between inner and outer diameters of pressings is a subject which is well explored and about which much has been written. Additional pre-emphasis is often and may here be applied at inner diameters to compensate somewhat in advance for translation loss. Unfortunately, there is an engineering proclivity toward making hard and fast rules for "shop practice," to cover all such points as diameter equalization and reference pre-emphasis. The trouble is that rules do not take into account the varying character of program material. The method which is satisfactory for a piano — velocity microphone pickup is not applicable to a bright orchestral picked up with a wide-range condenser. With material which is originally bright there is a severe limit on the amount of effective pre-equalization. Fortunately in a binaural system the two channels are not necessarily matched for frequency response, and in Fig. 3 it will be found that in the de-emphasis circuit (plate) of the first stage of the "inside" channel a 2.7K resistor is used to leave pre-emphasis in effect above about 3300 cps.

A general development probably not too far away is the "half-mil" point which can only be associated with cartridges having extremely low motional impedance. When such cartridges become available in manufacture, the inside-outside range and distortion of LP's in general will be vastly improved, and the binaural translation loss factor will be negligible. As for present practice, it has been found generally acceptable to maintain approximately a 50 μs (3300 cps turnover) differential between inner and outer binaural bands in the original recording. Depending upon the program material the outside band might be 50 or 100 μs pre-emphasis, and the inner band 100 μs or 100 μs + 50 μs, correspondingly.

Assuming that binaural recordings are pressed in high grade plastic, the most serious surface

(*Continued on page* 138)

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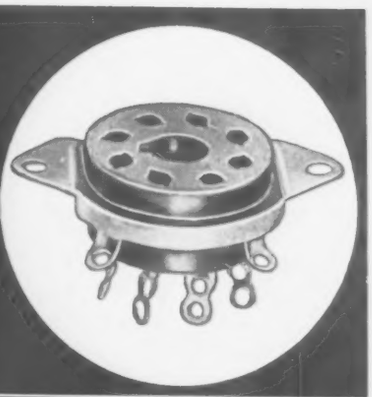
for High Production Applications

Recent addition to METHODE line of TUBE SOCKET ACCESSORIES is this new "Twist-On" type of tube shield and base, mounted in combination with molded sockets, as illustrated. Projecting lugs on shields provide direct ground to chassis under screw pressure and a reliable shock and vibration proof mount.

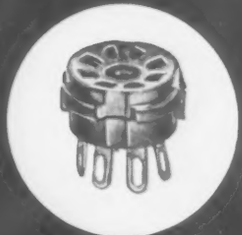


Top and Submount Octal Sockets, G. P. or Mica Phenolic, $1\frac{5}{16}$" or $1\frac{1}{2}$" mounting centers.

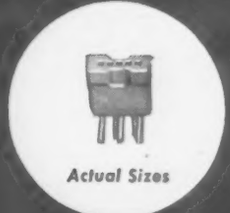
"J Lock" Type Miniature and Noval Socket and Shield Base Combination, G. P., Mica Phenolic or Ceramic Insulators.

Top and Sub-Mount Miniature and Noval Sockets, G. P., Mica Phenolic, Ceramic Insulators.

"Snap-in" Type Miniature and Noval Sockets and Shield Base Combination, G. P. or Mica Phenolic.



Miniature "Crimp-in" Sockets, G. P. Phenolic, with and without center shield.



Subminiature Tube Sockets, 4, 5, 6, 7 and 8 pin sizes, Mica Phenolic.

Actual Sizes

Other METHODE PRODUCTS include:

- Laminated wafer tube sockets
- Military tube and crystal sockets
- Panel Connectors
- Printed circuit sockets
- Tube shields

METHODE Manufacturing Corp.

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Delay Relays

PROVIDE DELAYS RANGING FROM 1 TO 120 SECONDS

FEATURES: — Compensated for ambient temperature changes from —40° to 110° F . . . Hermetically sealed; not affected by altitude, moisture or other climate changes . . . Explosion-proof . . . Octal radio base . . . Compact, light, rugged, inexpensive . . . Circuits available: SPST Normally Open; SPST Normally Closed.

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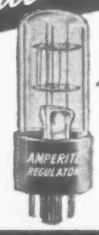
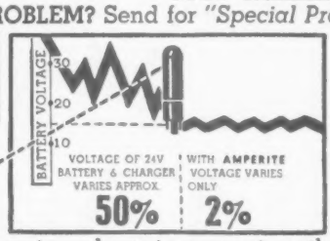




Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation . . . For currents of .060 to 6 Amps. . . . Hermetically sealed; not affected by altitude, ambient temperature, humidity.

Write for 4-page Illustrated Bulletin.

AMPERITE CO., Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto

GRANT SLIDING DEVICES

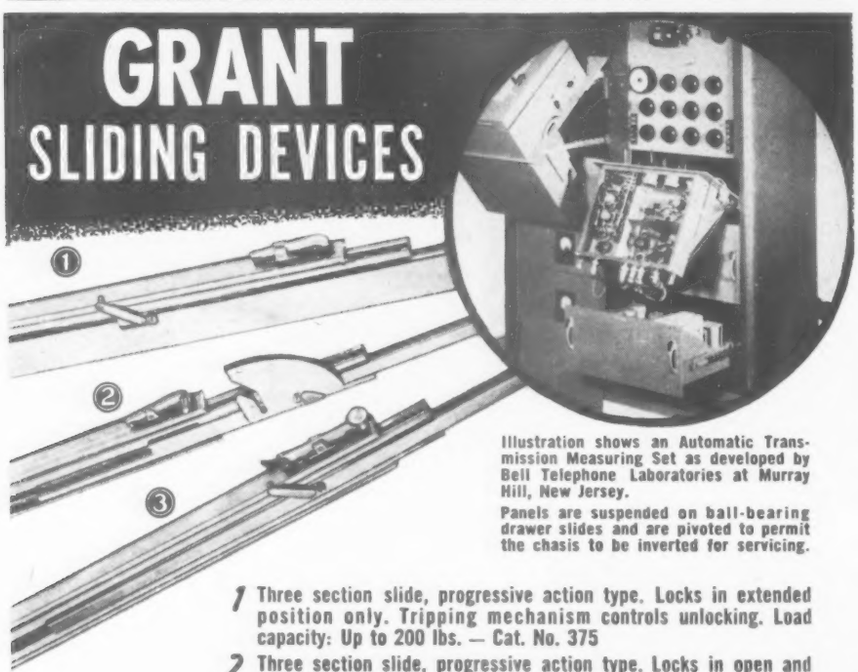


Illustration shows an Automatic Transmission Measuring Set as developed by Bell Telephone Laboratories at Murray Hill, New Jersey.

Panels are suspended on ball-bearing drawer slides and are pivoted to permit the chasis to be inverted for servicing.

1 Three section slide, progressive action type. Locks in extended position only. Tripping mechanism controls unlocking. Load capacity: Up to 200 lbs. — Cat. No. 375

2 Three section slide, progressive action type. Locks in open and closed positions. Provided with quadrant to allow for tilting to 90 degrees. Load capacity: Up to 200 lbs. — Cat. No. 364

3 Three section slide, progressive action type. Locks in extended position only. Thumb release controls unlocking. Load capacity: Up to 200 lbs. maximum. — Cat. No. 371

FURTHER INFORMATION WRITE — ELECTRONIC ENGINEERING DIVISION

GRANT PULLEY & HARDWARE CO.

31-87 Whitestone Parkway, Flushing, N. Y.

The foremost name in Sliding Devices

noise will be that of ticks and pops. Such noise here, however, will take on a random left-right character and as such is distinctly objectionable because of the directional effect. Hence the recorded level must not be lowered in an attempt to permit full "curve" equalization of bright original material.

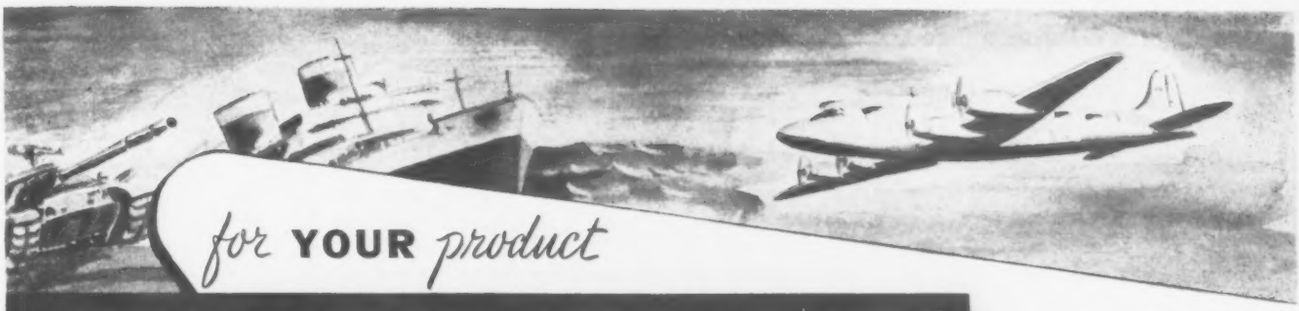
When experimental recordings were made using 6-in. microphone spacing and earphone playback, phasing was of course necessary. But contrary to what might at first be expected, phasing of playback *speakers* is unnecessary for material recorded indoors (rather than outdoors.) With any spacing of microphones in excess of ear spacing, phase becomes random in view of the acoustics of both the original room and the playback room. However, in playing back material which was recorded in the open, with no confining walls, phasing may well become desirable, especially if the acoustical environment of the playback speakers is on the "dead" side.

Fig. 6: Close-up of binaural recording shows the two bands of grooves

By now, most of us are well aware of the fact that a real distinction exists between standard monaural and binaural systems. Any comparison is unfair at the start because the two media are not comparable on any real basis. The extension of the aural medium by addition of dimension, direction and perspective is important not only for vitalizing the musical catalogs we are building but also for extending useful repertoire into fields such as plays and other documents, where the third dimension communicates enough additional information to make the difference between failure and success.

Of commercial necessity we have had to rule out earphones as the playback mechanism, albeit their rigorous binaural nature. We thus descend into a morass of conjecture relating to position of loud speakers, acoustical reflection characteristics of side and back walls, shape of room, etc., all applied to the room in which playback occurs. Here none but the broadest rules may be drawn, since even mass-produced living

(*Continued on page* 140)



for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

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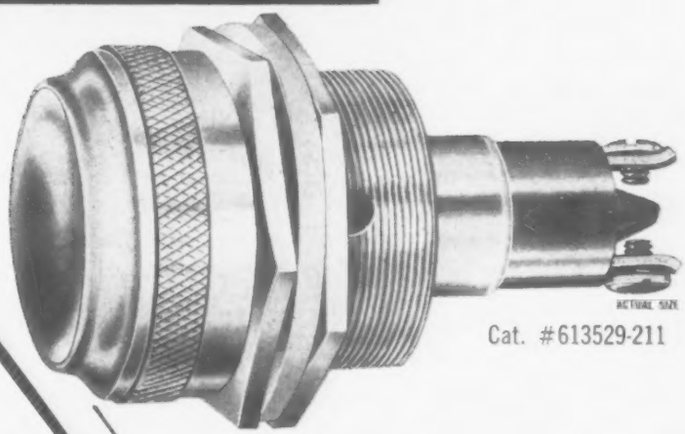
THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.



ACTUAL SIZE

Cat. #613529-211

This BIG one

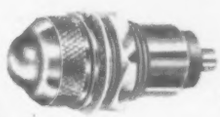
or

this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.



ACTUAL SIZE

Cat. #8-1930-621

Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.

Write for the Dialco HANDBOOK of PILOT LIGHTS

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The DIAL LIGHT COMPANY of AMERICA

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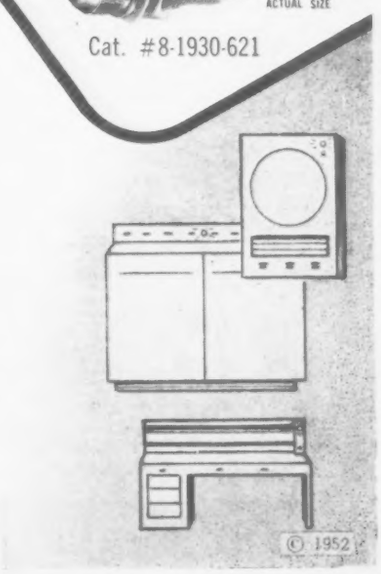

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NEW! Type 2004 Voltage Calibrator

MAKES YOUR OSCILLOSCOPE AN ACCURATE VISUAL VOLTMETER!

- Measures peak to peak voltage magnitude of complex or sinusoidal waveform from 10 millivolts to 100 volts within ±2%.
- Direct reading front panel meter indicates location of AC axis with respect to negative voltage peak. Accuracy ±3%.
- Provides externally available square wave for checking and recompensating scope probe attenuator.
- Eliminates repeated disconnection of calibrator leads by use of front panel switches.

SPECIFICATIONS

Voltage Ranges: 100, 30, 10, 3, 1, 0.3, 0.1, 0.03, 0.01 volts peak-to-peak full scale • **Duty Cycle Range:** 5% to 95%, direct reading • **Accuracy:** Voltage—±2% of full scale. Duty cycle — ±3% • **Calibrator Frequency:** Approximately 1 KC • **Input capacity:** The internal wiring of the calibrator will add approximately 20 mmf to the signal lead • **Power Source:** 105—125 volts AC, 60 cps, 65 watts • **Size:** 10½" H x 7" W x 8" D • **Price:** $165. F.O.B. Plant •

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Electronic-controlled equipment — a plan, TV set, production machine — functions badly or not at all when the electronic heart goes bad; sometimes causing loss of life. To prevent this failure of your equipment, Alden has dedicated a whole new line of components for PRACTICAL PRODUCTION DESIGN and UNINTERRUPTED OPERATION BY 30-SECOND REPLACEMENT OF UNITS by non-technical personnel.

Simplify layout and production with Alden Terminal Board

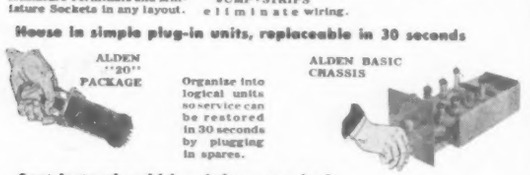
PREPUNCHED TERMINAL MOUNTING BOARD takes Miniature Terminals and Miniature Sockets in any layout.

MIN. STAKING TERMINALS — Components snap in — are held for speedy soldering.

JUMP-STRIPS eliminate wiring.

Completely mounted circuits readied for housing.

House in simple plug-in units, replaceable in 30 seconds



ALDEN "20" PACKAGE

Organize into logical units so service can be restored in 30 seconds by plugging in spares.

ALDEN BASIC CHASSIS

Spot instantly which unit has gone bad

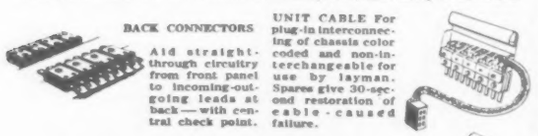
MINIATURE INDICATING LIGHT

MINIATURE TEST JACK

MINIATURE INDICATING FUSE HOLDER

Tiny sensing elements that isolate and instantly indicate clearly to a layman the unit needing replacement.

Bring all connections to central check point, instantly accessible



BACK CONNECTORS Aid straight-through circuitry from front panel to incoming-outgoing leads at back — with central check point.

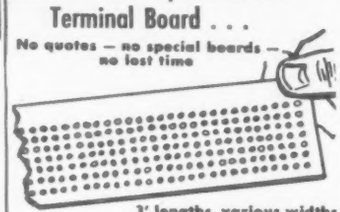
UNIT CABLE For plug-in interconnecting of chassis color coded and non-interchangeable for use by layman. Spares give 30-second restoration of cable-caused failure.

Send for Alden's Component Handbook: "Ideas, Techniques, Designs"

ALDEN PRODUCTS CO. 121 N. MAIN STREET, BROCKTON 64, MASS.

Here's the story on Alden Terminal Board . . .

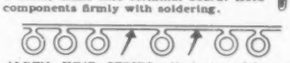
No quotes — no special boards — no lost time



3' lengths, various widths chop off what you need

MINIATURE STAKING TERMINALS

4 sizes, stake into terminal board. Hold components firmly with soldering.



ALDEN JUMP STRIPS eliminate wiring of common circuits. Snip off the ones you want to by-pass. Staked in under the staking terminals.

Here's how Alden Terminals permit plug-in unit approx. 50% smaller

Mounting 3 condensers and 7 resistors on Alden Terminal Board, this unit has 20 Alden Terminals, plus a 4 Jump Strip (in addition to tube socket and plug-in base connections.) For this same circuitry, turret type terminals would demand the unit to be about twice this size — to allow space to wrap around and solder. Alden Terminals hold lead solid for soldering. Without excess metal, permit fast heat transfer for easy soldering and unsoldering.

ALDEN STAKING TERMINAL Sawtooth grip holds wire for soldering. No excess metal—rapid heat transfer — easy soldering

CONVENTIONAL SOLID TERMINAL Requires manipulation space for wrap around pliering — extra space and longer heating to solder

ALDEN "20" PLUG-IN BASE 1 13/16" SQUARE

SEND FOR free samples, or order Lab. Kit #25 of comprehensive assortment of mounting board, terminals, sockets. Price $11.50.

rooms are decorated and carpeted differently.

In the case of standardization of recording characteristic curves a basic truth was finally recognized, wherein it is obviously both ineffectual and impossible to standardize the *recording curve*. What we try to standardize is the *playback curve* only. Thus in developing techniques for binaural recording insofar as microphone placement is concerned, the basic truth must always be kept in mind—that playback (on the average) will take place using 2 speakers separated perhaps 12-15 ft. against a wall in a room of corresponding size and fairly random acoustics.

As binaural disc as a medium develops, there will no doubt be a great deal of expert activity in the realm of "where to put the microphone" and "studio acoustics," and there will be many interim pet theories expounded. Without a conclusive amount of experience at this point, we can only suggest a few directions in which *not* to go. For instance, the business of about-facing the band on stage and playing into microphones in opposite corners of the stage wings is extraordinarily unnatural in effect. Wall reflections abuse the reality, and treatment of the walls to inhibit reflections pulls the teeth out of the binaural head. The bright synthetic modern studio acoustic appears definitely out from the binaural standpoint. In general, any studio or hall which has been treated with the idea in mind of creating an "even" frequency distribution of energy per square foot,—the "mix 'em up" philosophy,—is lowest on the binaural scale.

And the one unhappy malpractice which has been in vogue for 20 years of broadcast and recording,—that of the small and odd-shaped, acoustically odd and unnatural control room is absolutely fatal for producing binaural. Note is taken of various broadcast and recording company executives who, for very good reasons, insist on listening to their records in an audition room about the size and shape of an "average" living room with similar acoustics. Yet the records are produced and balanced in a studio control room which is about as far away as one could get from the living room prototype, both in size, shape, proportion, acoustics, and relative position in the room of loudspeaker and listener.

For binaural records, it would be better in these control rooms that earphones be used, for making binaural productions will probably become much more of an *art* than the regular monaural ever was.

Federal announces the first successful

ENCAPSULATION

of SELENIUM RECTIFIER STACKS

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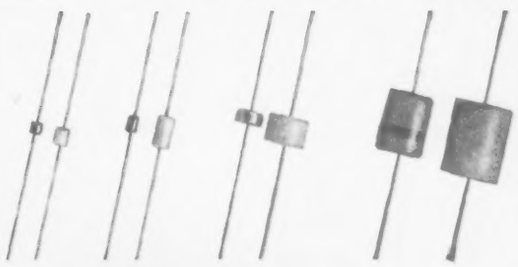
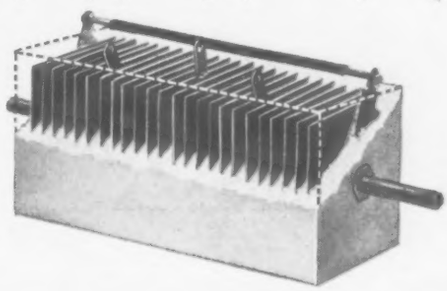
APPLICATIONS RANGE FROM TINY RECTIFIERS TO SUB-ASSEMBLIES AND COMPLETE POWER SUPPLIES





ENCAPSULATION OFFERS THESE MAJOR ADVANTAGES:

- Expands the application range of rectifiers
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- Assists heat dissipation at high altitudes
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A unique development in component-sealing —opening to industry a new concept in

MILITARY EQUIPMENT DESIGN

FEDERAL—America's *pioneer* in selenium rectifiers—now enables manufacturers for the first time to obtain these versatile AC-to-DC power conversion units in encapsulated form . . . to use them where special conditions formerly made their application impossible!

Encapsulation gives *new flexibility* to military equipment designers . . . offers a new means of greater protection against vibration, mechanical abuse, moisture, fungus, salt air corrosion and other hazards . . . plus faster heat dissipation in rarified atmosphere.

Sub-assemblies comprising transformers, capacitors, resistors and other components —*inter-connected with selenium rectifiers*—may now be assembled in equipments as single expendable blocks. Broad opportunities are offered to printed circuits involving numerous components. Encapsulated rectifiers also provide an improved replacement for oil-filled and other special applications.

For full information on Federal encapsulation of selenium rectifiers, power supplies and complete sub-assemblies of various components, write to Selenium-Intelin Division, Dept. F-266.

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BENSONHURST 6-9200
world's largest manufacturer of tv antennas & accessories

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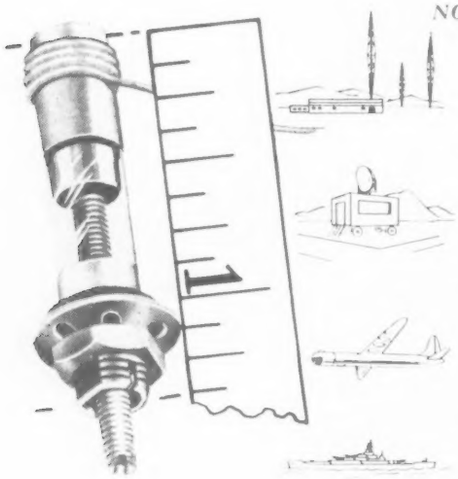
JFD PISTON TYPE VARIABLE TRIMMER CAPACITORS

in both civil and military equipment



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- Spring loaded piston made of special invar alloy having extremely low temperature coefficient of expansion.
- Silver band fused to exterior of precision drawn quartz or glass tube serves as stationary electrode.
- Piston dimensional accuracy is held to close tolerance maintaining minimum air gap between piston and cylinder wall.
- Approximately zero temperature coefficient for quartz and ± 50 P.P.M. per degree C. for glass units.
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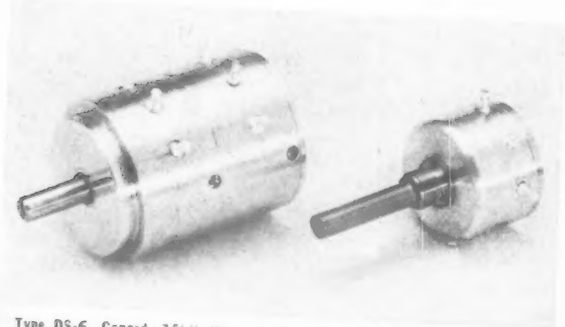
- Dielectric strength equals 1000 volts DC at sea level pressure and 500 volts at 3.4 inches of mercury.
- 10,000 megohms insulation resistance minimum.
- Operating temperatures, −55 C. to +125 C. with glass dielectric. And −55 C. to +200 C. with quartz dielectric.
- Over 100 megohms moisture resistance after 24 hours exposure to 95% humidity at room temperature.

Write for Form No. 199

83-5378



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Custom design, both mechanical and electrical, is a featured CORNELL service. Precision linear and NON-linear pots may be designed to meet customer's requirements. Taps and special winding angles anywhere up to 360 continuous winding can be incorporated into both linear and non-linear precision potentiometers.

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PERSONAL

Dr. Urner Liddel has joined the central office staff of Bendix Aviation Corp. in Detroit as a director of product development. Before joining Bendix, Dr. Liddel was Chief, Physics Branch, AEC; and, prior to that, Director, Physical Sciences Division, ONR.

Dr. Robert E. Samuelson has been appointed chief engineer of the Motorola Research Laboratory in Phoenix, Ariz. He was formerly head of the Communications Research Section.

SAMUELSON

MELOY

Thomas Meloy, president of Melpar, Inc., Alexandria, Va., a subsidiary of the Westinghouse Air Brake Co., has been appointed director of research of the Westinghouse Air Brake organization.

W. M. Jones has been named manager of the Electronics Div. of Thompson Products, Inc., Cleveland 3, Ohio.

John Bodnar has been appointed manager of potentiometer sales by the G. M. Giannini & Co., Pasadena, Calif. Formerly an engineer with RCA, he also served as sales engineer for the Brush Development Co.

Charles W. Ketteman, Jr. has joined the California Electronic Services Co. as president and general manager.

A. G. Roth has joined the staff of Heppner Manufacturing Co., Round Lake, Ill., specialists in electro-magnetic and magnetic devices.

F. D. Meadows has been appointed general sales manager of the Dage Electric Company and the Dage Electronics Corp. of Beech Grove, Ind.

Control Room Layout

In the article "Television Control Room Layout" (Oct. 1952 TELE-TECH, p. 48), which was presented by R. D. Chipp at the 1952 Sixth Annual NARTB Conference in Chicago, the text and caption for Fig. 4 should read "Video control booth is on left" instead of "Announce booth is on left."

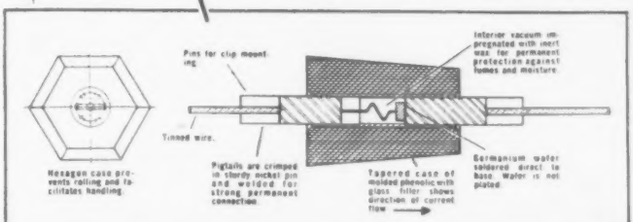
Announcing Radio Receptor's new range of

R&R Germanium Diodes

FEATURING POLARITY AT A GLANCE!

Keynoting sound design features and simplicity in construction, the new Radio Receptor Germanium Diodes will give a maximum of trouble-free operation even under the most adverse conditions.

Normally in diodes such as these, one side of the germanium wafer is plated so that it may be soldered to the base... but Radio Receptor's improved production methods make it possible to *omit* plating, thus eliminating possible flaking and improving quality.


Pins for clip mounting.
Interior vacuum impregnated with inert wax for permanent protection against fumes and moisture.
Tinned wire.
Hexagon case prevents rolling and facilitates handling.
Pigtails are crimped in sturdy nickel pin and welded for strong permanent connection.
Tapered case of molded phenolic with glass filler shows direction of current flow
Germanium wafer soldered direct to base. Wafer is not plated.

CODE NO.	MINIMUM CURRENT AT 1 VOLT FORWARD MA	MAXIMUM CURRENT AT 10 VOLTS REVERSE MA	MAXIMUM CURRENT AT 50 VOLTS REVERSE MA	AVERAGE‡ RECTIFIED CURRENT MA	MINIMUM INVERSE PEAK VOLTS	MAX. CONT. OPERATING INV. VOLTS
1N48	4.0	—	0.833	50	83	70
1N51	2.5	—	1.667	25	50	40
1N52	4.0	—	0.150	50	85	70
1N63	4.0	—	0.050	50	125	100
1N64	Minimum DC current in 44 MC test circuit is 100Ⓜ a				20	16
1N65	2.5	—	0.200	50	85	70
†1N69	5.0	0.050	0.850	40	75	60
*1N70	3.0	0.025	0.300	30	125	100
1N75	2.0	—	0.050	50	125	100
†1N81	3.0	0.010	—	30	50	40

*†JAN Types
‡Average half wave rectified current at 60 CPS and 25° C. Consult us for ratings at other conditions. All ratings at 25° C.

The distinctive tapered shape of the glass-filled phenolic cartridge body indicates the direction of current flow, while the hexagon form assures ease of handling – prevents rolling, especially when the leads are cut off to permit mounting the diode in clips.

Submit your germanium diode application problems to us.... We'll be glad to make recommendations without obligation!

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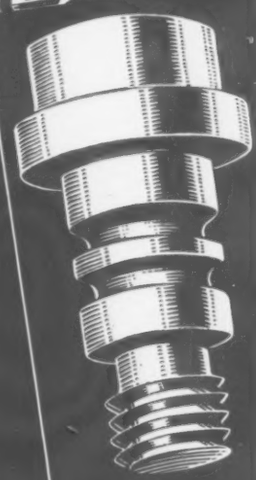

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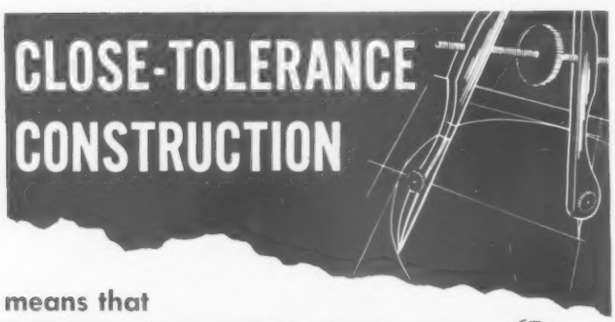

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Officers are Col. Sidney K. Wolf, president, E. Labin, vice-president, V. J. Nexon, vice-president and treasurer, and V. J. Nearing, secretary. Dr. S. J. Begun is chairman of the board.

Col. S. K. Wolf is an associate professor in the School of Commerce, Accounts

Col. Sidney K. Wolf

and Finance at New York University. Prior to this he has been sales manager, Wire & Radio Transmission Systems at Federal Telephone and Radio Corp., where he was engaged in the sale of systems engineering, promotion, and installation of microwave wire communication systems, aviation communication, navigation, and blind landing systems. He was also assistant general commercial director of International Standard Electric Corp., manufacturing and sales unit of the International Telephone and Telegraph Corp., where he was engaged in the sale and promotion of their products throughout the world. He distinguished himself in the military service as a Colonel of the U.S.A.F., and was also deputy director of the Radio and Radar Division of the War Production Board, and Director of the Communications Division of the Munitions Board. Col. Wolf is active in the directorship of various companies including Reeves Soundcraft Corporation, Cinerama, Inc., Audio-Video Corp., and Bergen Wire & Rope Corp.

Emile Labin was associated with the International Telephone and Telegraph Corp. for sixteen years in various executive capacities concerning research and development telecommunication ap-

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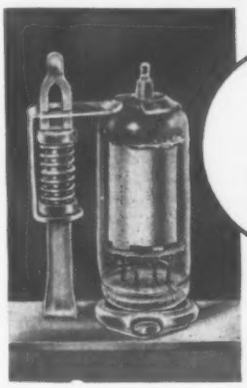

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paratus and systems. He has been technical director of the Federal Telecommunication Laboratories where he was in charge of coordination and supervision of important commercial and military electronic developments. Prior to this in 1941, he directed the beginning of this organization for IT&T following his pioneer communication work with International Telephone and Telegraph Corp. in France. Mr. Labin is well

Emile Labin

known in the field of electronics, being the author of more than 75 U. S. Patents, and having an exceptional record of practical industrial achievements.

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The American Institute of Electrical Engineers is sponsoring a symposium on "The Science of Music and Its Reproduction", beginning November 7, 1952, in Room 502, Engineering Societies Building, 33 West 39 Street, New York City, N. Y. from 7 to 9 PM. Each lecture will be approximately one hour and a half in length followed by a period for discussion. The tuition fee for the complete symposium (necessary to cover operating expenses of the Basic Science Div., AIEE) will be $3.50 for members of AIEE, IRE, ASME, ASCE, AIME, ANA, AMS, AES, and AIP; and $5.00 for non-members. Single lectures will be $1.00 for members of aforementioned societies and $1.25 for non-members. Advance registration through J. J. Anderson at AIEE Headquarters, 33 West 39 Street, New York 18, N. Y. Following is a list of dates and topics that will be presented.

Nov. 7 "Recordings from the Nineteenth Century to the Present", E. T. Canby—Record Critic, Audio Engineering; P. Miller—Music Director, New York Public Library

Dec. 11 "The Physics of Music and Hearing"; W. E. Knock—Bell Telephone Laboratories

Jan. 15 "Performance Criterial of Loudspeakers"; F. H. Slaymaker—Stromberg-Carlson Co.

Feb. 20 "Some Notes on Modern Techniques of Recording and Reproducing"; C. J. LeBel—Audio Devices Inc.

Mar. 12 "The Relation Between Frequency Response and Transients in the M. S. Corrington—Radio Corporation of America

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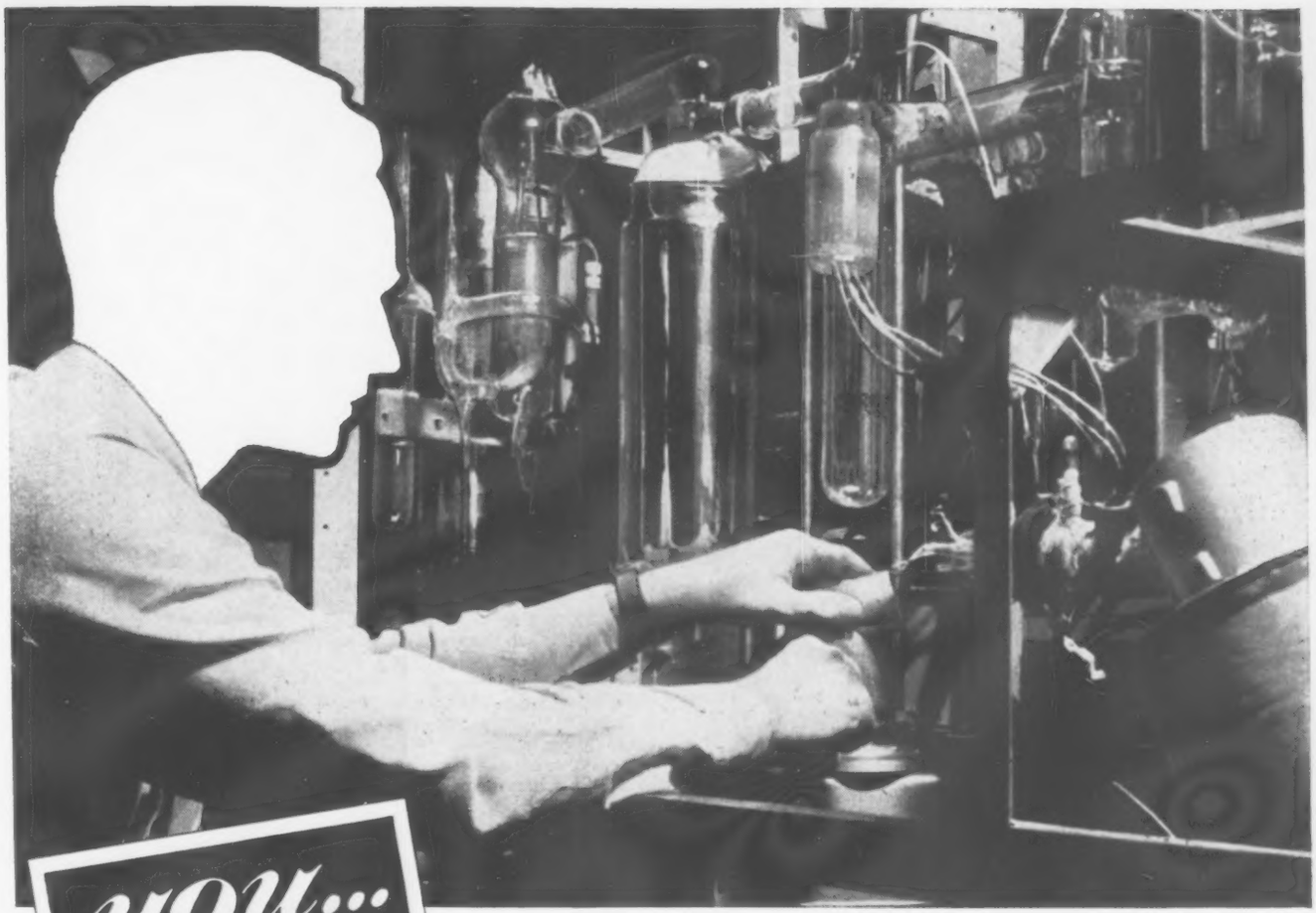

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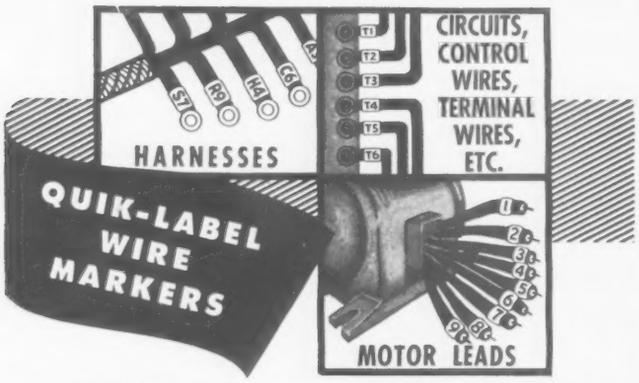

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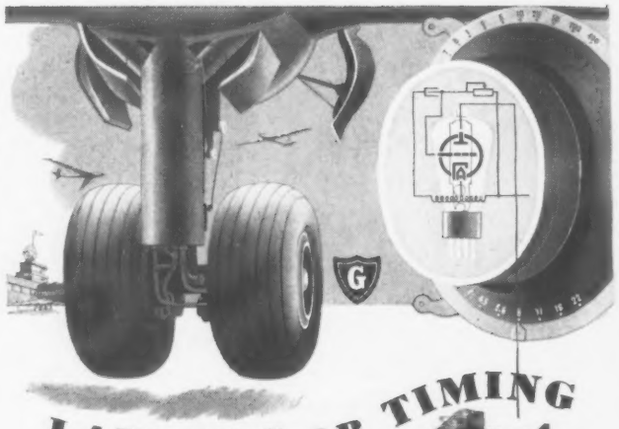

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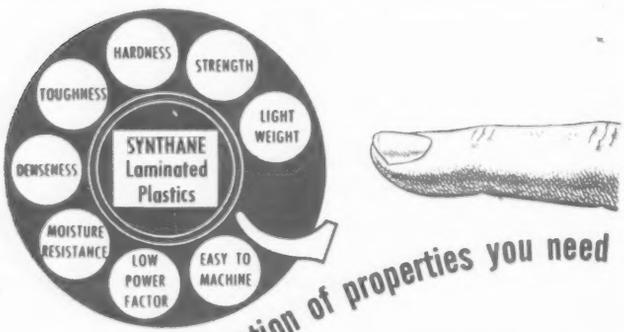

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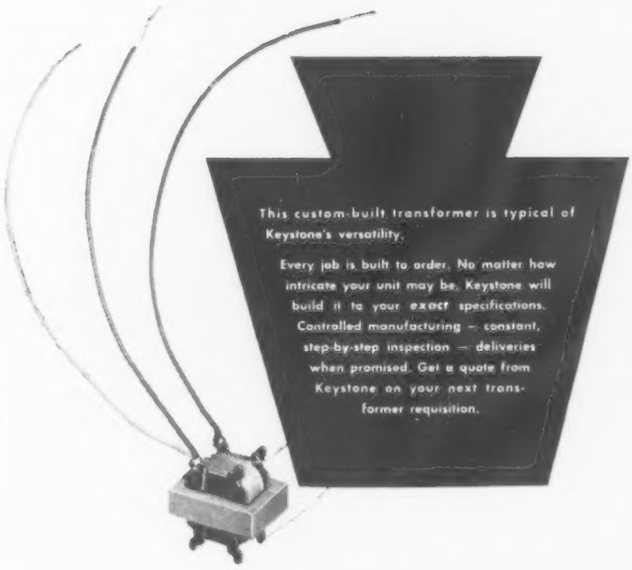
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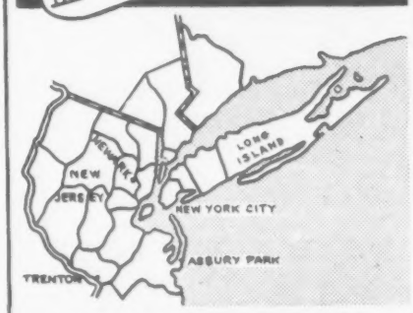

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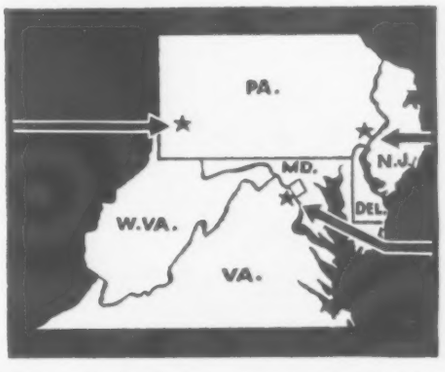

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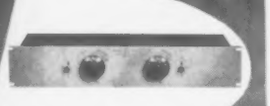

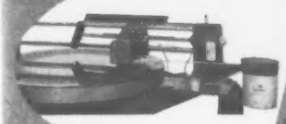

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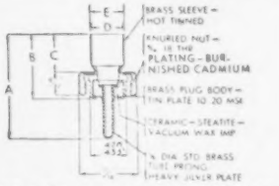
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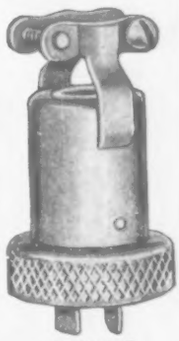

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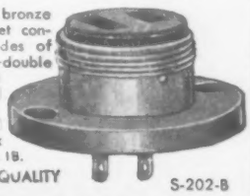

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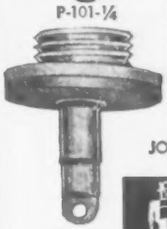

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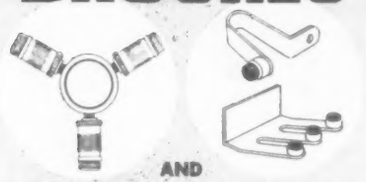
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Warren Wire Co., Pownal, Vermont has appointed the D. G. Quinlan Co., Philadelphia, Pa., to cover eastern Pennsylvania, southern New Jersey, and the states of Maryland and Delaware.

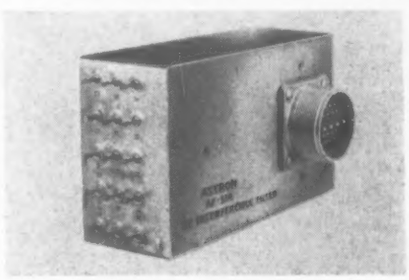
Sintercast Corp. of America, Yonkers 2, N. Y., has appointed J. W. Mull, Jr., to cover the Indiana, western Ohio and northern Kentucky territory.

Microwave Equipment Co., North Caldwell, N. J. has appointed the John B. Tubergen Co., Los Angeles, Calif., to represent its line of waveguide instruments and accessories in the southern California area.

James B. Lansing Sound, Inc., Los Angeles, Calif., has appointed the Leo B. Naylor Co., 1250 First Ave., South, Seattle 4, Wash. to represent its speakers, systems and components in Oregon, Washington and British Columbia.

New Astron Service

Astron Corp., 255 Grant Ave., East Newark, N. J., manufacturers of metallized paper capacitors and standard R-F noise supression filters is now offering the services of its noise suppression laboratory together with its enlarged engineering staff to manufacturers with specific noise suppression problems in Armed Services equipment, and in equipment for the Electronic Industries.



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Operational Amplifier
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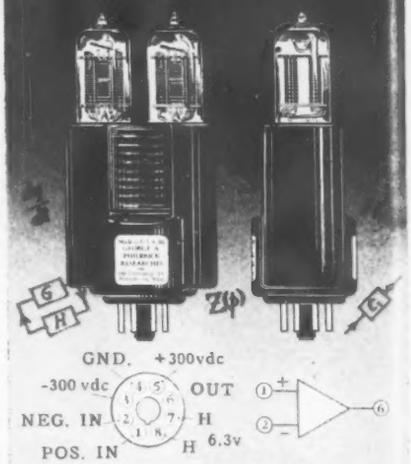

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VOLTAGE GAIN: 10,000 plus.
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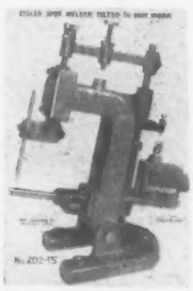

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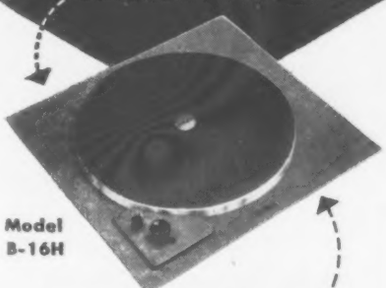

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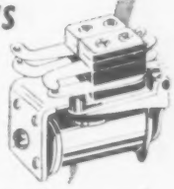

RELAYS . . . WORLD'S LARGEST STOCK!

Your requirements of large or small quantities of relays can be quickly supplied from our huge stock.

Wide variety of types, all made by leading manufacturers. Each relay is brand new, inspected and fully guaranteed by Relay Sales.

✔STANDARD TELEPHONE RELAYS ✔SHORT TELEPHONE RELAYS ✔DUAL TELEPHONE RELAYS ✔SLOW ACTING RELAYS ✔SEALED RELAYS ✔ROTARY RELAYS ✔MIDGET RELAYS ✔KEYING RELAYS ✔DIFFERENTIAL RELAYS ✔PLATE CURRENT RELAYS ✔ANTENNA SWITCHING RELAYS ✔"BK" SERIES ✔STEPPERS & RATCHET RELAYS ✔LATCHING & INTERLOCKING RELAYS ✔MECHANICAL ACTION RELAYS ✔VOLTAGE REGULATORS ✔OVERLOAD & CIRCUIT BREAKERS ✔REVERSE CURRENT RELAYS ✔AIRCRAFT CONTACTORS ✔MOTOR & CONTROL DEVICES ✔TIMERS ✔SOLENOIDS ✔RELAY ASSEMBLIES

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RELAY SALES CATALOG NOW READY

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Relay Sales
833 W. CHICAGO AVE.
DEPT. 6, CHICAGO 22, ILL.

TEST-ADJUST
TELEVISION SETS AT
Your
CONVENIENCE

Even Without Station Test Pattern or in Remote, Weak Signal Areas

SUPREME
MODEL 665

Net Price $389.50

The SUPREME COMPOSITE VIDEO GENERATOR provides the same type of sync and blanking signal as the TV station—even the equalizing pulses. In addition, it incorporates a video section which generates a special test pattern for analysis and adjustment of TV sets. Other patterns or pictures can be presented by using auxiliary equipment connected to the special "gated" video input section of this versatile instrument. The Model 665 should not be confused with the cross-hatch or bar-pattern generators. The Supreme Model 665 supplies a COMPOSITE VIDEO SIGNAL.

Every TV station sends a COMPOSITE VIDEO SIGNAL when telecasting a program or a test pattern. This COMPOSITE VIDEO SIGNAL is composed of—(1) a synchronizing and blanking signal to lock the free running raster into a frame of two interlaced fields, and—(2) a video signal to control the amount of light and produce the picture (which may be a program scene or a test pattern for analysis purposes).

A television set will produce a picture only when it is supplied with a COMPOSITE VIDEO SIGNAL. To check any TV set properly, you must have a COMPOSITE VIDEO SIGNAL.

Why lose time and money waiting for that ideal scene or test pattern to check a TV set? In fringe or weak signal areas, you are strictly in the "driver's seat" with a SUPREME COMPOSITE VIDEO GENERATOR. Write SUPREME, Inc., Dept. 13, GREENWOOD, MISSISSIPPI, for descriptive folder.

Since 1927

SUPREME
Testing Instruments
"SUPREME BY COMPARISON"

TUBE TESTERS • OSCILLOSCOPES
SIGNAL GENERATORS • MULTI-METERS
FOR RADIO AND TELEVISION

BULLETINS

TV Transmitters

"TV Transmitters" is the title of the new 12-page bulletin just released by Standard Electronics Corporation, Newark, N. J., a subsidiary of Claude Neon, Inc. Bulletin TTS-61 presents the electrical and mechanical specifications on the S-E 500 watt visual — 250 watt aural basic unit with Add-A-Unit design amplifiers which provide complete transmitters of 5, 10, and 20 KW output.

Crystals

A complete new catalog of crystals has just been issued by the James Knights Company of Sandwich, Illinois, manufacturers of stabilized quartz crystals. Forty-five different crystals are listed.

Airborne and Ground Station Equipment

A four page brochure presenting airborne and ground station equipment and Accessories for Radio Telemetering has been published by Applied Science Corporation, Princeton, N. J., Post Office Box 44. The folder features large illustrated charts showing building block accessories in complete PW or PDM systems for airborne equipment.

Tubes

Products of Raytheon Manufacturing Co., Waltham, Mass., are shown in a new, illustrated, three-color catalog. A brief history of the company and a photo layout of its various plants are followed by detailed descriptions of the products of each of Raytheon's four divisions; receiving tube, power tube, equipment and television and radio. A page is devoted to an outline of the concern's research activities.

Triode

A new data sheet describes the Los Gatos brand type 254 Medium-Mu Triode manufactured by Lewis and Kaufman, Inc., 52 El Rancho Ave., Los Gatos, Calif. The tube is illustrated, given outline dimensions and general electrical characteristics.

As We Go to Press . . .

Editors TELE-TECH (telegram)

KBTV DENVERS SECOND TV STATION BEGAN REGULAR PROGRAMMING ON OCT 12TH WITH THE PROGRAMS OF CBS AND ABC. DURING THE PAST WEEK KBTV HAS BEEN RUNNING SERIES OF ENGINEERING TEST PROGRAMS ON CHANNEL 9 WITH ITS INTERIM POWER OF 12000 WATTS ERP. RECEPTION REPORTS HAVE INDICATED COVERAGE FAR BEYOND ALL EXPECTATIONS REPORTS OF EXCELLENT RECEPTION AT CHEYENNE WYOMING COLORADO SPRINGS AND ACROSS THE CONTINENTAL DIVIDE AT GRANBY COLORADO AND MANY OTHER POINTS INDICATE SERVICE WILL BE EXTENDED TO AN AREA WITHIN A RADIUS OF 100 MILES. THIS COVERAGE IS ATTRIBUTED TO THE IDEAL TRANSMITTER LOCATION ON LOOKOUT MOUNTAIN WHICH IS 2500 FEET ABOVE DENVER. TV RECEIVER SERVICE MEN REPORT VERY LITTLE ADJUSTMENT IN RECEIVERS AND ANTENNAS NECESSARY TO RECEIVE THE CHANNEL 9 SIGNAL. THE ROCKY MOUNTAIN ELECTRICAL LEAGUE OFFICIAL INDUSTRY SOURCE OF SET TABULATIONS REPORT 57964 SETS IN THE AREA AS OF OCT 1ST. THIS IS AN INDICATION OF THE MARKETS ENTHUSIASM FOR TV SINCE THE FIRST TV STATION (KFEL-TV) BEGAN OPERATION ONLY THREE MONTHS AGO. PREDICTIONS ARE THAT UP TO 100000 SETS WILL BE SOLD IN THE AREA BY JAN 1ST 1953.

JOE HEROLD
STATION MANAGER KBTV

ENGRAVING and MARKING
The Green Engraver

ENGRAVES, ROUTS, PROFILES and MODELS

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to your OPEN WIRING CABLE SUPPORT PROBLEMS

Use the ALL NYLON "NyLoc" CABLE CLIPS
for tough conditions and unusual heat, etc.

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Use the ETHYL CELLULOSE "EthoLoc" CABLE CLIPS
for average conditions and maximum economy

Send for details and FREE samples.
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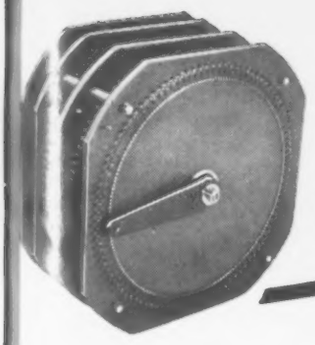
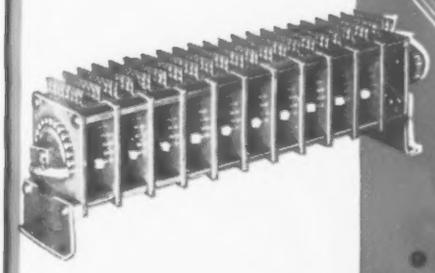
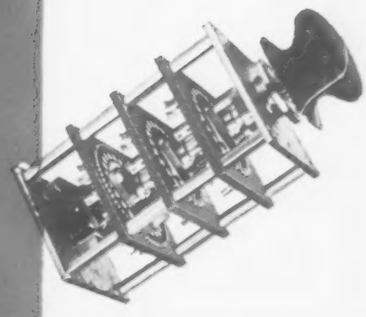


Quick Switches





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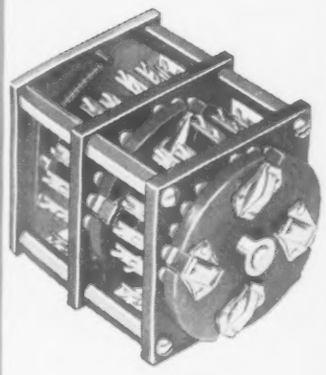
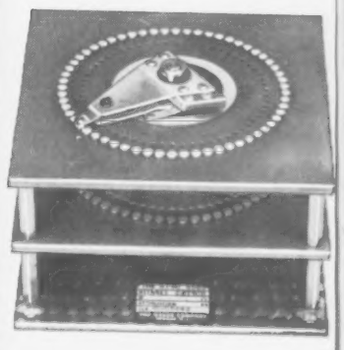
DAVEN SPECIALTY





And the "specialty of the house" is double-barreled . . . first, choose from hundreds of standard units to satisfy your needs—for quick switch delivery . . . second, Daven can effect quick 'switches' or changes from standard units to special switches, by using components at hand. Standard parts can be adapted for *your* switch. That too makes for speed, dependability, economy. Write for more detailed data.

Here's Why Daven Switches Excel

- Low and uniform contact resistance.
- Minimum thermal noise.
- High resistance to leakage.
- Trouble-free operation and long life.
- Roller-type positive detent action.
- Depth of unit not increased by addition of detent.

Standard Daven Switches may be the answer to many of your problems. Therefore, check this list below for many of the popular types that are readily available.

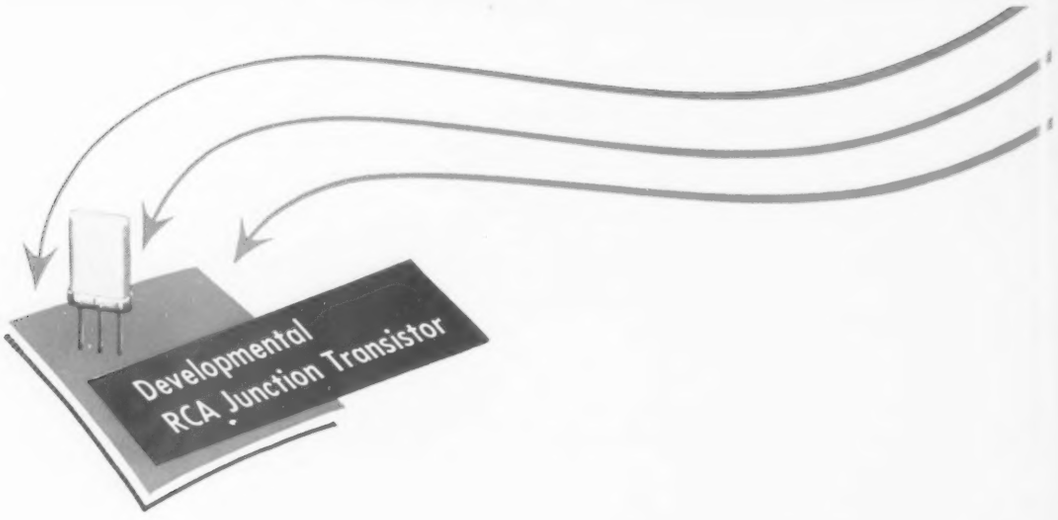
Type	Operation	Maximum No. of Positions (per pole)	Maximum Poles per Deck	Deck
G1A	Make before break	24	1	1 3/8"
C1A	Make before break	31	1	1 3/4"
C2B	Break before make	15	1	1 3/4"
D1A	Make before break	47	1	2 1/4"
D7A	Make before break	14	4	2 1/4"
D8B	Break before make	7	4	2 1/4"
D9A	Make before break	9	5	2 1/4"
E3A	Make before break	47	2	2 3/4"
E8B	Make before break	12	4	2 3/4"
E11A	Make before break	15	6	2 3/4"
F1A	Make before break	60	1	3"

It's Free!

Your copy of Daven's complete, new bulletin on switches. Write for it today.

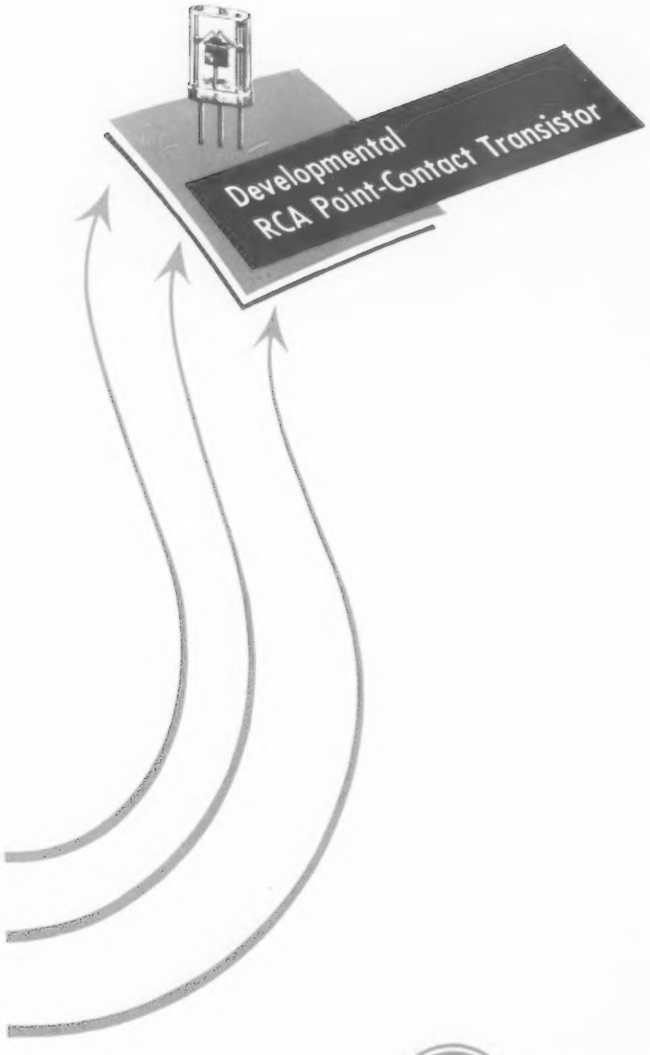
THE DAVEN CO.

179 CENTRAL AVENUE • NEWARK 4, NEW JERSEY



An RCA progress report

...on *Transistors*



MORE THAN FOUR YEARS AGO, RCA embarked on a research and development program to determine the practicability of transistors in the field of electronics. The early work was concerned with the principles, designs, and applications of point-contact transistors; and later was expanded to include junction transistors and other similar semiconductive devices.

As an important recent result of the studies on point-contact transistors, RCA Tube Department engineers have made in the laboratory experimental point-contact transistors which oscillate at frequencies above 200 megacycles, one of which exceeded 300 megacycles. This achievement opens the way to the use of transistors in FM radio and in VHF television, in addition to their previous potentialities for low-frequency applications including audio and switching uses.

This work has also led to considerable success in developing junction transistors for audio and radio amplifier applications. A point of particular significance is that much progress has been made in the development of practical assembly techniques.

Point-contact types are now being sampled to equipment manufacturers and government agencies as a part of our development program. It is anticipated that junction transistors will be available for similar sampling in the near future.

Although much remains to be done, promising results have been attained in controlling the characteristics of both types of transistors; pilot production runs are being made.

Meanwhile RCA is pushing forward its development program to assure its customers that the commercial transistors of the future will be made to the same high standards of quality and dependability as the RCA electron tubes of today.

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N.J.**

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